PB89-229504

Superfund Record of Decision (EPA Region 8) Libby Ground Water Contamination, MT (Second Remedial Action), December 1988

(U.S.) Environmental Protection Agency, Washington, DC

30 Dec 88

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

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Emergency and
Remedial Response

EPA/ROD/R08-89/022
December 1988

PB89-229504

EPA

Superfund Record of Decision:

Libby Ground Water, MT

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16. Abstract (Limit: 200 words)

The Libby Ground Water Contamination site (also known as the Champion Mill site or the Libby Pesticide site) is located on the Champion International Corporation lumber and plywood mill in the City of Libby, Lincoln County, Montana. Champion is the third owner of the facility, which has been in operation since 1946. The area around the site includes residential areas and businesses. The site is bordered on the west by Flower Creek, on the east by Libby Creek, and on the north by the Kootenai River. The city and surrounding areas have a population of approximately 11,000. The contaminated soil/source area is within the confines of the facility; however, ground water contamination extends well into the City of Libby. Wood treating fluids and their constituents, including creosote and PCP, are the contaminants of concern at the site. They are found in soil and sediments at several different locations, including former waste pits, tank storage areas, and butt dip and treatment sites. The contamination is the result of spent fluids, overflow of treatment tanks, and spills. In addition to creosote and PCP, certain carrier fuels or oils were used at the site and contributed VOC contaminants. Investigations at the site were initiated by the State in 1979 after a residential well was found to smell of creosote. A ROD signed in September 1986 provided an alternate water source to residents whose wells were contaminated. The site
(See Attached Sheet)

17. Document Analysis a. Descriptors

Record of Decision - Libby Ground Water Contamination, MT
Second Remedial Action
Contaminated Media: soil, debris, gw
Key Contaminants: VOCs, organics (PAHs), oil

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 132
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

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16. Abstract (continued)

has been divided into three operable units; however, they require concurrent remediation. The operable units are the soil/source area within the confines of the facility; the upper aquifer, historically used for drinking water and irrigation but currently severely contaminated; and the lower aquifer, highly contaminated with oil and non-aqueous phase liquids (NAPL). The primary contaminants of concern affecting the soil, sediments, and ground water at the site are VOCs including benzene; other organics including dioxin, PAHs (creosote constituents), and PCP; metals including arsenic; and oil.

The selected remedial actions for this site have been developed based on operable units. The selected remedial action for the soil/source area includes excavation and consolidation of approximately 30,000 yd3 of unsaturated soil and debris in the waste pit area, followed by a two-step enhanced biodegradation process composed of enhanced natural biodegradation and subsequent transfer to a land treatment unit consisting of a 3.5-acre lined treatment cell for land farming and final deposition; in situ bioremediation treatment of saturated soil in the waste disposal pit using a closed loop system involving ground water pumping and physical treatment in a fixed bed bioreactor with reinjection through a rock percolation bed, and in situ biodegradation stimulation to prevent further leaching of source material to ground water (recovered NAPL will be processed in an oil/water separation and stored onsite for recycling and incineration); and capping of the waste pit, butt dip, and tank farm areas. The selected remedial action for the upper aquifer includes in situ ground water bioremediation of the upper aquifer that is separate from the process used in the saturated zone of the waste pit area. The selected remedial action for the lower aquifer includes implementation of a pilot test for the oil-contaminated lower aquifer using biorestoration in conjunction with oil recovery and oil dispersion techniques (this is an interim remedy for the lower aquifer); implementation of institutional controls including deed, land use, and ground water restrictions; and onsite ground water monitoring. The estimated present worth cost of this remedial action is $5,777,000 with annual O&M of $670,200 for year 2, $521,200 for years 3-5, $232,200 for years 6-8, and $80,000 for 9-30.

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U.S. EPA Region VIII
Montana Operations Office

RECORD OF DECISION

Libby Ground Water Superfund Site
Lincoln County, Montana

December 1988

Record of Decision
Declaration

Libby Ground Water Site. Libby. Montana

Statement of Basis and Purpose

This decision document represents the selected remedial action for the Libby Ground Water Superfund Site ("Libby Site"), in Libby, Montana developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act and, to the extent practicable, the National Contingency Plan. This decision is based on the administrative record for the site.* By signature below, the State of Montana concurs in this Record of Decision. All determinations reached in the Record of Decision were made in consultation with the State of Montana, which has participated fully in the development of this Record of Decision.

Description of the Selected Remedy

I. The response action that the Environmental Protection Agency has selected was developed as a final remediation strategy for clean up of soils and source areas, and remediation of the upper aquifer. The lower aquifer action is an interim remedy. The final remedy for that action will ultimately be determined at a later date, although this Record of Decision develops the basis for the final remedy determination. The response selected consists of three major sub-actions within the overall response action, each of which is described in detail in the Decision Summary. Each of the sub-actions units poses near and long-term public health and environmental threats of varying magnitude.

Soils & Source Areas

Soils in some areas of the Libby site are contaminated by various organic and inorganic wood treating compounds. Contaminated soils in the unsaturated and saturated zones present a public health threat via direct contact and ingestion. They also pose a direct environmental threat and public health threat because they act as source materials by releasing contaminants to the ground water.

Ground Water/Upper Aquifer

Ground water in the upper aquifer emanating from the Libby site is contaminated primarily by organic wood treating compounds. The ground water poses a public health threat due to the possibility of ingestion of water taken from shallow residential wells. Indirectly, another public health threat is created because ground water may be used for irrigation of food products. The ground water contamination may pose an environmental threat because of potential slow advancement of the plume toward the Kootenai River.

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*An index guide to the documents contained in the administrative record is attached to the Record of Decision.

Ground Water/Lower Aquifer

Ground water in the lower aquifer is contaminated with wood treating compounds as well, in dissolved concentrations similar to the upper aquifer. In addition, large volumes of non-aqueous phase liquids (NAPL) are also present in the lower aquifer, providing a long term source of dissolved species contamination. Because of the NAPL presence, the lower aquifer ground water poses a greater potential health threat than the upper aquifer. However, the potential for exposure to contaminants from the lower aquifer is very low because there are no water wells completed in the lower aquifer downgradient of the site prior to the Kootenai River.

II. The major components of the selected remedy and the concerns that they address are as follows:

Concern	Response Action
Contaminated Soils	Contaminated soils from the tank farm area, butt dip treatment area and any other source locations as may be identified will be excavated and placed in the waste pit area, which also contains contaminated soils and debris. Contaminated soils from the unsaturated zone will undergo a two-step enhanced biodegradation treatment. In this treatment process, natural degradation of contaminants will be stimulated and accelerated using concentrated mixtures of microbes, nutrients and other energy sources. The initial treatment will be conducted in the waste pit area. Upon reaching an optimum contaminant degradation a lift of soils will be transferred to the second phase treatment cell which will also act as the final disposition location. Eventually, all contaminated soils in the waste pit above the saturated zone will be removed to the final treatment location. The treatment cell will be lined with low permeability materials to resist leachate infiltration and adsorb contaminants from liquids. The bottom barrier system will also assure no migration of contaminants from the treatment cell. After contaminant concentrations have been reduced to acceptable levels, a protective cap will be installed over the second-phase treatment cell to reduce surface water infiltration and preclude direct contact. Post closure care, including

monitoring and inspection, will be conducted for the treatment cell after placement of the cap.

A combination of in-situ bioremediation treatment processes will be utilized to degrade organic contaminants in the saturated zone of the waste pit area. A closed loop, bacteria rich ground water injection and extraction system will be the primary technique used to degrade contaminants adsorbed on soil matrices and in oil product in the saturated zone. Extraction wells will be installed to remove NAPL from the source area. Recovered NAPL will be processed in an oil/water separator and stored on site for recycling or incineration.

At completion, the waste pit area will be closed, in accordance with RCRA closure requirements. A protective cap will be required over the waste pit, butt dip and tank farm areas. Post-closure care, if appropriate, will be required for these areas as well.

Upper Aquifer

The oil recovery wells will also be used to collect highly contaminated ground water, which will undergo treatment in a fixed bed bioreactor prior to reinjection through a rock percolation bed. This system will greatly reduce contaminant migration outside of the immediate waste pit area ground water system.

An in-situ, enhanced biorestoration program, separate from the processes employed to degrade contamination in the saturated zone of the waste pit source area, will be initiated in the upper aquifer to reduce contaminant levels. This innovative treatment technology will achieve a faster and more effective ground water cleanup than traditional pump and treat systems because contaminants in the dissolved phase, as well as those adsorbed into aquifer matrices, will be degraded concurrently. Non-aqueous phase liquids will also be degraded, but at a slower rate.

The in-situ treatment process will reduce contamination in the upper aquifer to the required risk and ARAR-based levels. The current prohibition on new use of the aquifer will continue until these levels are achieved, as will the buy-water plan approved in the 1st operable unit ROD.

Lower Aquifer Efforts to develop an effective oil recovery system for the lower aquifer have been unsuccessful to date. Extensive study has been devoted to this issue during the RI/FS (see Appendix F of the Feasibility Study Report). The lower aquifer, which to EPA's knowledge has not been used for consumption purposes down-gradient of the site, contains unknown quantities of oily product. The complex hydrogeologic properties of the lower aquifer indicate that attempts to withdraw oily product using well developed oil reservoir technologies would only be 50% effective at a maximum. A 50% recovery efficiency would result in little reduction of potential environmental and/or public health threat.

However, EPA is not convinced that some methods to remediate the lower aquifer are not feasible. The Agency is therefore unwilling to dismiss the lower aquifer under a no-action scenario at this time. This remedy selection prescribes implementation of a biorestoration test program similar in scope to that conducted for the upper aquifer. The pilot test will be conducted to determine if enhanced biorestoration of the aquifer, in conjunction with oil recovery and oil dispersion techniques, is an effective method of remediation. This remedy also includes continuation of the prohibition on well drilling in the lower aquifer. At the conclusion of the pilot program, a Record of Decision will be issued which will select a final remedy for the lower aquifer.

Ground Water Restrictions There is currently a prohibition on the drilling of new water supply wells in the city of Libby. This ordinance was passed by the City in support of the September, 1986 Record of Decision for the first operable unit. This selection of remedy provides for continuation of that ordinance until ground water is cleaned to acceptable levels. It also identifies a potential need for a similar prohibition in portions of Lincoln County outside the city of Libby should the aquifer restoration processes not degrade the contaminant plume prior to migration (if moving) outside the city limits. The prohibition on drilling in the upper aquifer may be rescinded after risk and ARAR levels are reached. The prohibition on drilling in the lower aquifer will continue throughout the extent of the treatment pilot program. The prohibition will be re-examined during the ROD for final remedy in the lower aquifer.

Monitoring	This selection of remedy requires active monitoring of remediation actions to assure treatment effectiveness throughout the lifetime of the actions. Monitoring of the land treatment cell will be required to determine if contaminants are migrating. Long term monitoring of lower and upper aquifer water quality is also required to determine further movement of contaminant plumes, assure protection of public health and, if plumes are shown to migrate, assess potential damage to the Kootenai River.
5-Year Remedy Review	In accordance with Section 121(G) of CERCLA this selection of remedy calls for a review of the remedial actions conducted at the Libby site five years from implementation of remedial actions to assure human health and the environment are being protected. This review process will be required only if a determination is made that hazardous substances remain on-site above health based levels. If the review determines that additional action is required to protect public health and the environment, EPA will take such action as is appropriate. This review is in addition to the remedy selection to be made at the conclusion of the pilot study for the lower aquifer.
Deed Restrictions	As part of the remedy for the soils operable unit, deed restrictions will be required of the property owner. These will require the property owner to insert language in the current registered deed which identifies the locations of hazardous substances disposal and treatment areas, and restricts the future use of these areas.

Declarations

The selected remedy for clean up of contaminated soils and ground water in the upper aquifer is protective of human health and the environment, is cost effective, and attains Federal and State requirements that are applicable or relevant and appropriate (ARAR) to this remedial action. Further discussion of one ARAR, RCRA Land Disposal Restrictions, is warranted because attainment of the ARAR will likely be achieved through a variance.

According to EPA Land Disposal Restrictions for First Third Scheduled Wastes, land disposal of RCRA K001 wastes is prohibited after August 8, 1988, unless certain maximum concentration levels are met. Because bottom sediment sludges from treatment of waste waters from wood-preserving processes containing creosote and/or pentachlorophenol are present in the waste pit area at Libby, and these are considered K001 wastes, this restriction is considered applicable to Libby, although an exemption is granted until August 8, 1990 (40 CFR Section 268.33(c)). Field tests of the preferred remedy for soils treatment indicate that contaminant concentrations can be reduced to below best demonstrated available technology concentrations for all currently regulated K001 compounds, after land disposal and treatment, with the exception of pyrene.

Placement of some contaminated soils into the land treatment unit will occur after the August 8, 1990 deadline, and therefore land disposal restrictions are applicable for the Libby site. It is anticipated that a demonstration of no-migration will be conducted prior to these dates, and a no-migration variance granted, to assure land treatment and disposal of these wastes will be compliant with RCRA land disposal requirements.

The remedy for the lower aquifer operable unit is protective of human health and the environment, in that it prohibits use of the aquifer. The remedy is not in compliance with identified ARARs, in that concentrations of one or more contaminants will be above requirements. This ROD invokes a temporary waiver of ARARs for the lower aquifer response action only, based on Sections 121(d)(4)(A) and 121(d)(4)(C) of CERCLA. Compliance with ARARs is inappropriate at this time, as this remedy is part of an interim remedial action which will attain ARARs, if technology can be found to remediate the lower aquifer, and compliance with ARARs is technically impractical at this time. This waiver is temporary only - a full evaluation of ARARs and technical practicability will be made at the conclusion of the pilot study, in the next Record of Decision. The lower aquifer remedy is cost effective.

Alternatives considered in the Feasibility Study Report for the identification, collection and treatment of the non-aqueous phase contaminants found in the lower aquifer have been determined to be technically impracticable. The innovative pilot biorestoration program required under this remedy selection will be evaluated at conclusion to determine remediation effectiveness. If the pilot study suggests that full implementation of a biorestoration program in the lower aquifer will be an effective remedial action, EPA may require such implementation and the statutory preference to comply with ARARs and for treatment as a principal element of the remedy will be satisfied.

All final remedies selected for this remedial action satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as a principal element and alternative treatment technologies to the

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Record of Decision
Summary

I. Description of Site

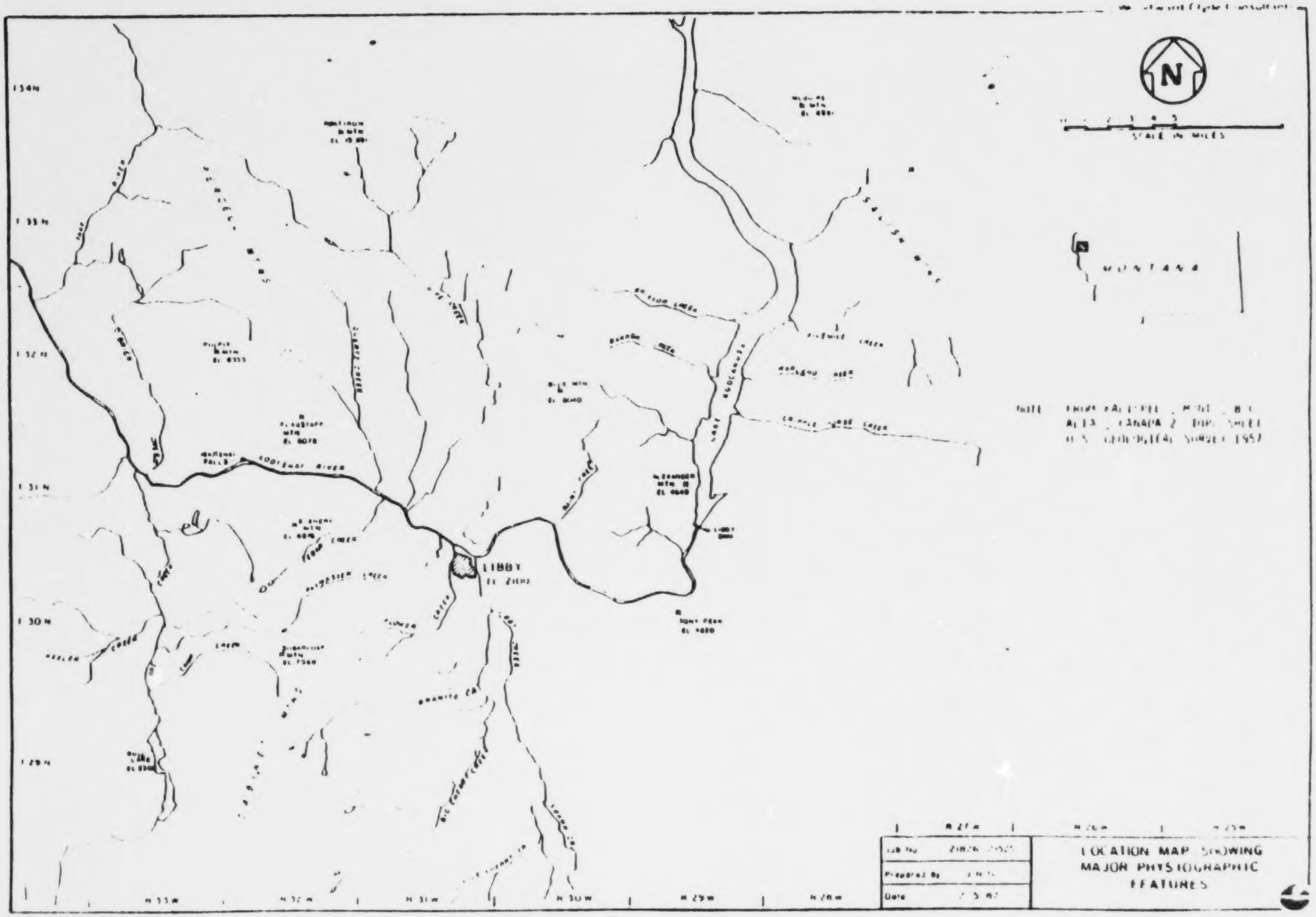
The Libby Ground Water Superfund site (also known as the Champion Mill site or the Libby Pesticides site) is located in the northwestern corner of Montana in the town of Libby, Lincoln County (Figure 1). The surface expression of the site is owned by Champion International Corporation and contaminant source areas are within the confines of an active lumber and plywood mill. The mill facilities are located on the eastern edge of the city of Libby and are bounded on the east by Libby Creek, on the south by private property, on the west by U.S. Highway 2 and on the north by the Kootenai River (Figure 2). The remainder of the site consists of contaminated ground water extending well into the city of Libby.

The city and surrounding areas have a population of approximately 10,960 according to a 1980 census. Residential neighborhoods and businesses are immediately adjacent to the industrial property along the extent of the western boundary, separated from the mill physically by fencing and usually roadway.

Northwestern Montana is comprised of mountainous terrain, heavily timbered with abundant surface water. The Cabinet Mountains Wilderness is located west and south of Libby, the Purcell Mountains to the north, and the Salish Mountains are east of the city. Much of the land in this part of Montana is federally owned and administered by the Kootenai National Forest. Locally, the site topography is flat, varying in elevation from 2,125 ft. mean sea level (msl) to about 2,070 msl. Average annual rainfall for the last 25 years, measured at the U.S. Forest Service Station, is 18.10 inches per year.

The predominant industries in the Libby area are timber harvesting and processing, mining and recreation. Champion International Corporation's Libby mill alone employs approximately 9% of the working force in Lincoln County. Mining is also an economically important industry in this area, particularly for silver and other precious metals in the Cabinet Range, and for vermiculite at the W.R. Grace facility just northwest of Libby across the Kootenai River. Tourism and recreational activities such as hunting, fishing and boating also positively impact the local economy.

Surface water is abundant in this part of Montana. Typically, intermontane valleys contain small streams, recharged by high-country snowpack, which feed into regionally important


LOCATION MAP SHOWING
MAJOR PHYSIOGRAPHIC
FEATURES
Date
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SCALE IN MILES
MONTANA
LIBBY
EL 2100
KOOTENAI RIVER
NOTE: FROM KALISPELL, MONT., B.C., ALTA., CANADA 2° TOPO SHEET U.S. GEOLOGICAL SURVEY 1957

Figure 1

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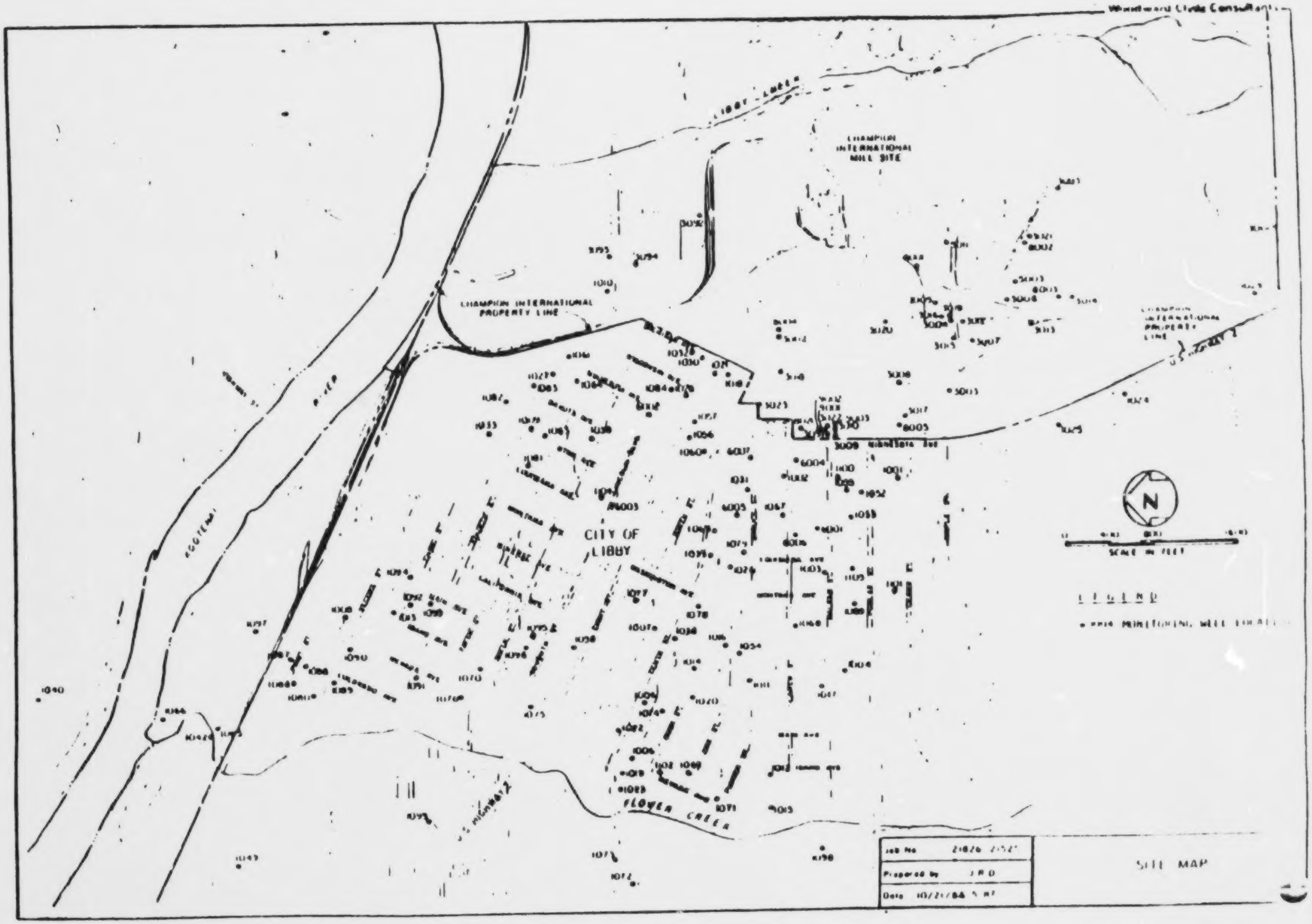
Woodward-Clyde Consultants
CHAMPION INTERNATIONAL MILL SITE
CHAMPION INTERNATIONAL PROPERTY LINE
CHAMPION INTERNATIONAL PROPERTY LINE
LIBBY CREEK
U.S. HIGHWAY 2
CITY OF LIBBY
FLOWER CREEK
KOOTENAI
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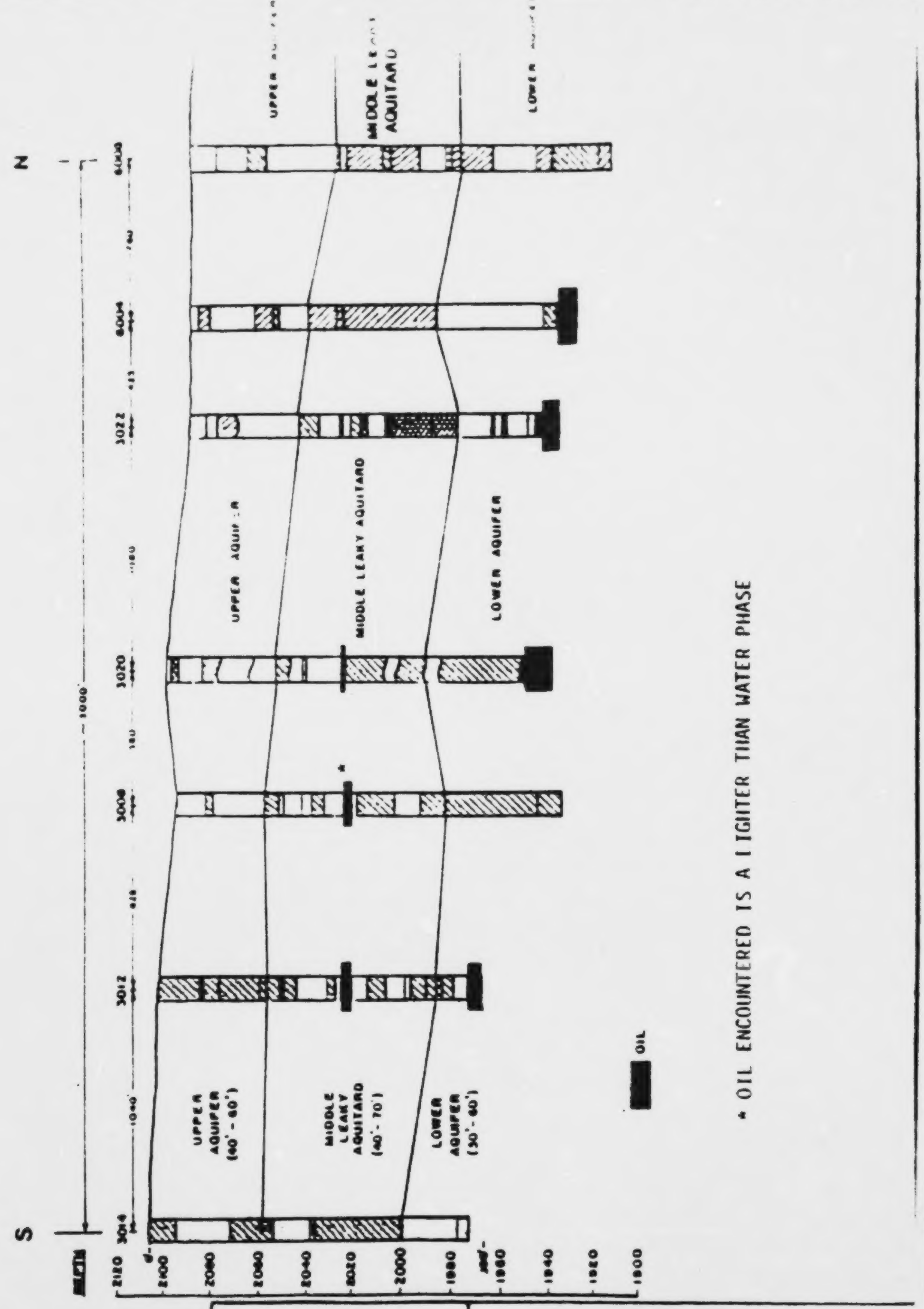
MONITORING WELL LOCATION
SITE MAP
Job No 21826
Prepared by JRD
Date 10/21/84

Figure 2

Figure 3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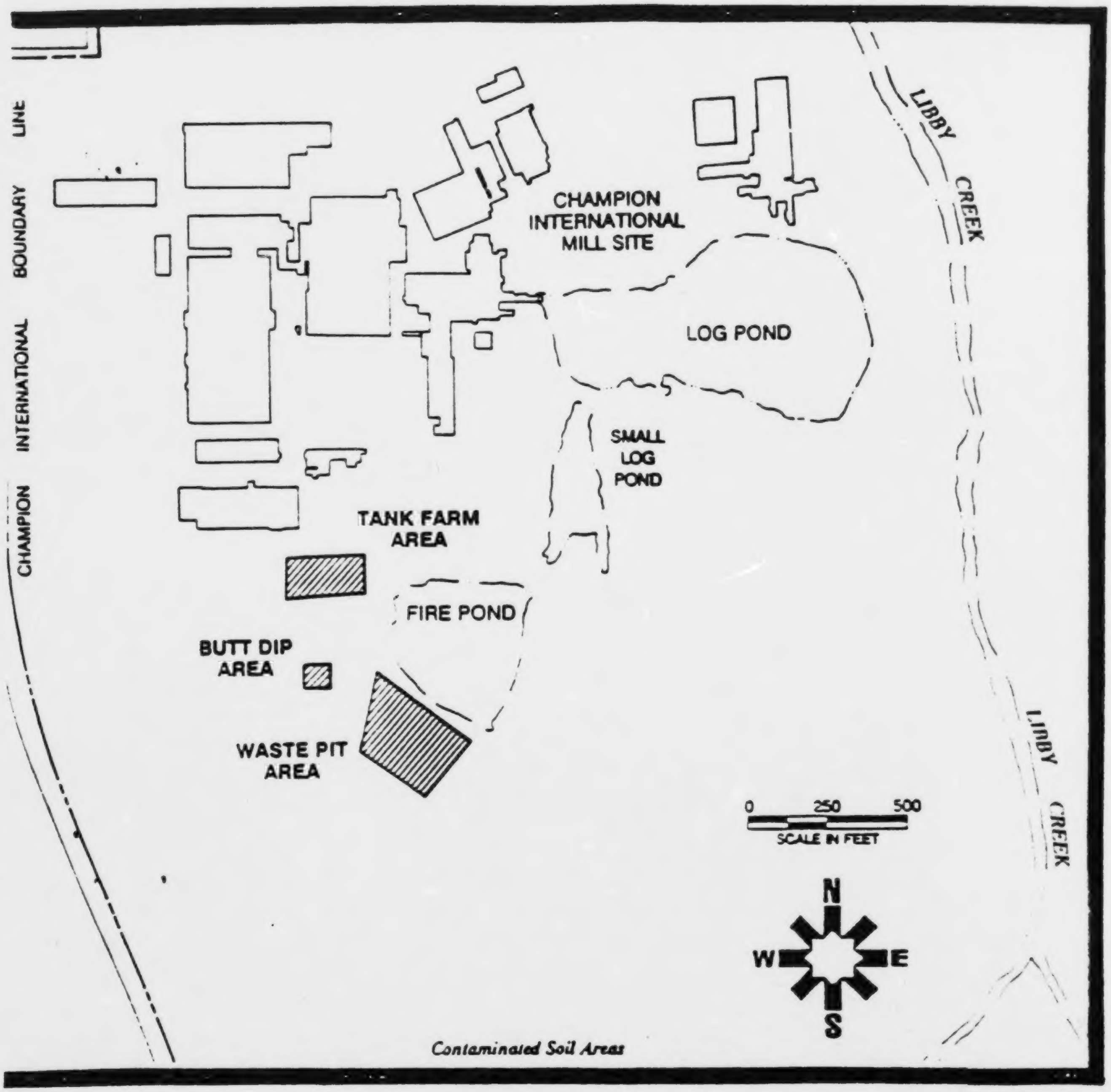
* OIL ENCOUNTERED IS A LIGHTER THAN WATER PHASE

Job No. : 21990-21525	GENERALIZED N-S HYDROGEOLOGIC CROSS-SECTION
Prepared by : W. S. T.	
Date : 12/23/87	


CHAMPION INTERNATIONAL BOUNDARY LINE
LIBBY CREEK
CHAMPION INTERNATIONAL MILL SITE
LOG POND
SMALL LOG POND
TANK FARM AREA
FIRE POND
BUTT DIP AREA
WASTE PIT AREA
0
250
500
SCALE IN FEET
N
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E
S
LIBBY CREEK
Contaminated Soil Areas

Figure 4

rivers. The city of Libby is bordered on the east by Libby Creek and the west by Flower Creek, both of which recharge the Kootenai River, the northern city boundary. Average flow of the Kootenai varies from 20,000 cubic feet per second (cfs) to 30,000 cfs.

The hydrogeological or ground water regime of the Libby area is characterized by glacial, glacio-fluvial and alluvial deposits which form a complex arrangement of interfingered water bearing and non-water bearing units. Two connected but hydrogeologically differentiated aquifers are present at the site. Ground water flow is prolific, consisting of a steep valley flow to the north from the southern part of the City, which is then redirected in a northwest trend by the Kootenai River alluvial plain, a local and regional ground water discharge. Ground water is located relatively close to the site surface, from 8 to 15 feet below grade (Figure 3).

The Champion mill property is industrial, with large buildings and warehouses used in the milling and sawing processes. Diversion water from Libby Creek recharges several ponds on site which are used for fire suppression or to float logs. Residual ash from burning is kept in a large pile on the eastern side of the property. Air emissions are principally the result of boiler operations and are regulated by State permit. An MPDES permitted outfall discharges treated effluent to the Kootenai River on the northern property boundary.

II. Site History and Enforcement Activities

The Libby Ground Water site is located on the Champion International Corporation lumber and plywood mill in the city of Libby, Montana. The Champion mill (hereinafter "facility") has been an active forest products processor for a number of years. The facility was first known as the J. Neils Lumber Company. Wood treatment operations began in approximately 1946 and continued until 1969.[1] St. Regis Corporation purchased the company in 1957 and continued wood treatment operations. In 1985 the facility was purchased by Champion International Corporation, the current owner. The facility purchase was part of the merger of St. Regis with Champion, at which time Champion assumed St. Regis' liabilities.

Wood treating fluids and constituents are known to have been disposed and spilled at several different locations at the facility during the early operation of the plant (Figure 4). Waste water, formed as vapor in the retorts, was placed in waste pits after treatment by a condenser and oil separator. Sludges which built up in the bottom of wood treating fluid tanks were periodically removed and hauled to an unlined waste pit. Overheating of the butt dip treatment tank fluids created foam-overs which spilled onto the ground. Spills occurred in the tank farm area and at the butt dip tank, and also around storage tanks. Spills varied greatly in quantity, and success of recovery attempts varied as well, thereby preventing accurate estimates of the total quantity lost to the environment.[2]

Four different wood treatment compounds have been identified as compounds used at the site, in varying amounts. Creosote, a substance composed almost entirely of polynuclear aromatic hydrocarbon compounds (PAHs), was used throughout the history of wood treating operations, often with a carrier fluid. Pentachlorophenol (Penta) use began in the early 1950s and continued until 1969. Penta generally was combined with a carrier oil, such as diesel, in a 19:1 ratio, carrier prevalent. A salt solution comprised of various inorganic compounds such as Copper-Chromium-Arsenate (CCA) was used for treating during the latter 1960s. Occasionally, a mixture of penta, mineral spirits, polyethylene-glycol, and wax was combined with a 1:1 creosote:fuel-oil mix for treatment.

The existence of a contamination problem at the Libby site was first investigated by the Montana Department of Health and Environmental Sciences (MDHES) Water Quality Bureau in April, 1979, when water from a newly drilled residential well was found to smell of creosote. In September of 1980, pursuant to CERCLA, the EPA Field Investigation Team began site investigation activities. EPA personnel and the Lincoln County Sanitarian met with St. Regis Corporation representatives at this time to discuss past wood treatment processes and waste disposal practices at its facility. St. Regis submitted a Notification of Hazardous Waste Site to EPA on June 10, 1981 listing U051, creosote as the type of waste.[3] Further investigations, including well water sampling, indicated that ground water in some locations was contaminated by pentachlorophenol as well as creosote compounds. Past waste disposal practices and wood treatment compound spills at the facility made it a prime suspect as the source of ground water contamination.

The Libby site was proposed for inclusion on the National Contingency Plan list of priority hazardous waste sites in December, 1982. The site was placed on the first National Priorities List in September of 1983, with a Hazardous Ranking System score of 36.67, making it eligible for remedial response action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

On October 11, 1983 EPA issued an Administrative Order on Consent (Docket # CERCLA VIII 83-03) stating that the site presented a potential threat for release of hazardous substances into the ground water. The Order directed St. Regis Corporation to begin remedial investigations, feasibility studies, and remedial action programs. Champion International Corporation assumed all responsibility for the Order when it acquired and merged with St. Regis Corporation in January, 1985. No lawsuits have been filed to date against Champion International Corporation or any other potentially responsible party for the Libby site to conduct cleanup activities.

Remedial investigation and feasibility study activities were begun in 1983 by St. Regis. The objectives of the investigations were to define the limits and extent of site contamination, and develop and evaluate available alternatives for minimizing and mitigating the endangerment posed by the site to human health and the environment. These investigative activities have resulted in Phases I through IV field investigation reports, reports of ongoing water sampling programs, laboratory and field tests to determine most effective site cleanup programs, and feasibility studies evaluating cleanup alternatives. A complete list of reports used to determine the remedies described in this Record of Decision is included in the administrative record.

A remedial investigation and feasibility study for operable unit 1 of Phase IV was completed in July 1986. It addressed public exposure to contaminated ground water. As a result of this investigation, EPA recommended that an alternate water source be supplied to residents whose wells were contaminated by ground water emanating from the facility. This recommendation was approved in a September 26, 1986 Record of Decision. Implementation of the remedial action was conducted by Champion International Corporation, pursuant to the existing administrative order. Investigative activities since that time have addressed the remainder of the environmental and public health threats posed by the site. Documentation of activities subsequent to the 1986 ROD is included in the Remedial Investigation Report, April 1988 and public review draft of the Feasibility Study for Site Remediation, November 1988.

Special Notice for remedial design and remedial action as described in Section 122 of CERCLA has not yet been provided to Champion International. EPA anticipates issuing Special Notice approximately two weeks subsequent to finalization of this ROD. Negotiations are predicted to commence shortly thereafter and culminate in a judicial consent decree for implementation of remedial design and remedial action, recovery of all past EPA expenditures related to the site, and provision for ongoing reimbursement of future EPA costs. It is anticipated that the State of Montana will also participate in the consent decree and seek reimbursement for past costs. The consent decree should be formalized no later than 120 days after issuance of Special Notice, but Champion International, MDHES and EPA have all expressed a strong desire to conduct the consent process in an expeditious fashion.

Technical discussions have been conducted between Champion (the potentially responsible party, or PRP), EPA and MDHES since site investigative work began in the early 1980s. Accounts of meetings and conversations are contained within the site administrative record. Of more particular interest and applicability to this remedy selection are discussions which have centered on issues raised during review of the first draft of the phase IV feasibility study report dated February, 1987. EPA and MDHES submitted detailed comments on this study to Champion in September, 1987 which identified numerous major deficiencies. Since that time meetings have been held generally every other month to try and resolve differences in process, technical interpretations and remedial alternative evaluation. Summaries of these meetings have been formalized into memoranda in the administrative record.

III. Community Relations History

Although community interest in the Libby site has been relatively low, EPA and MDHES maintained an active community relations program during RI/FS activities. Fact sheets or project updates were prepared at various stages to inform Libby residents of the status of site activities. MDHES and EPA conducted interviews of local officials and residents in January, 1988 to determine the adequacy of the agencies' information distribution system.

An administrative record has been established for the Libby site. The record is available near the site in the offices of the Lincoln County Sanitarian, 418 Main Avenue, Libby, Montana, and in the docket review room of the U.S. Environmental Protection Agency's Montana Operations Office, 301 S. Park, Helena, Montana. Records at both locations may be reviewed during normal business hours.

In order to assure that interested persons, including potentially responsible parties, may participate in the development of the Libby administrative record, the following actions have been taken:

1. Pursuant to Section 117(a) of CERCLA, a proposed plan was made available to Libby citizens, legislators, potentially responsible parties, and other persons. The plan summarized the RI/FS process, described the response action alternatives, and provided a brief analysis of the alternatives preferred by EPA and MDHES. The proposed plan was mailed to persons on the EPA mailing list, distributed in the weekly city newspaper, and made available at the public repository in the County Sanitarian's office. Notification of the availability of the plan was made via newspaper notice.

2. Concurrent with distribution of the proposed plan was the initiation of a 30-day public comment period to allow

persons to provide official comment on the plan and other documents contained in the administrative record.

3. In order to provide another opportunity for public comment and discussion on the proposed plan and other Libby site issues as necessary, a public meeting was held on November 29 at 7:00 p.m. in the Lincoln County Annex Building in Libby. The date, time and place of this public meeting was published in the proposed plan as well as two editions of the local newspaper. Also, public service announcements were broadcast as news items on the local radio station.

4. Verbal comments and questions were noted during the meeting. In all instances, responses were immediately supplied to the public at the meeting. Written comments have been accepted for the duration of the public comment period. A response has been prepared for each of these comments. The comments, questions and responses are contained in the Responsiveness Summary attached to this document.

Subsequent to the selection of remedial response actions described in this document, through the signing of this document, EPA will publish the Record of Decision as a final plan. Included in the final plan is a discussion of any significant changes, and the reasons for those changes, from the proposed plan. Included in the final plan will be a response to each of the significant comments or questions submitted during the public comment period. Announcement of the availability of the final plan will be made by notice in the Libby newspaper. The final plan will be made available for review in the public repository, and for review and copying at the EPA office in Helena, Montana. A thirty day public comment period will be provided for the final plan.

The availability of technical assistance grants for citizen groups was publicly noticed in various Montana newspapers during the spring of 1988. Further notice was verbally issued in Libby during a presentation to the local Rotary group, and to the Lincoln County Sanitarian, since he is the primary local contact for persons interested in the site. No grants were requested or awarded for this action.

IV. Scope and Role of Response Actions

The response actions selected for implementation at the Libby site are designed to alleviate the primary threats to public health and the environment, posed by contaminant sources and contaminant migration, for the soils and upper aquifer. The response action for the lower aquifer is intended to aid the

Agency in finding a reliable, cost effective clean up. While the response actions may be evaluated in terms of separate operable units or sub-actions, they are actually very dependent upon concurrent implementation. The following paragraphs briefly describe the three major sub-actions; soils, upper aquifer and lower aquifer. A more thorough characterization of the sub-actions (known as operable units in the FS report) may be found in the RI Report.[2]

Soils/Source Areas: Soils in some areas of the site are contaminated with wood treating compounds (Figure 4). These areas are considered "sources" because they provide an ongoing source of contaminant loading to the ground water through precipitation infiltration and leaching. They also pose a direct contact threat. In order to effectively address ground water clean up, the source areas must be cleansed of contaminants or isolated from the hydrogeologic system.

Upper Aquifer: The Libby ground water system has been severely impacted by the uncontrolled migration of wood treating compounds from the unsaturated zone, or source areas, into the shallow upper aquifer. The hydrogeologic system is generally characterized by highly transmissive deposits which transport a prolific ground water flow from the site north and northwest toward the City of Libby. The upper aquifer, located between depths of approximately 15 to 70 feet, is contaminated primarily by dissolved constituents. The upper aquifer is most commonly used for drinking water and irrigation wells down gradient, although there is currently a prohibition against drilling new wells in the city of Libby, and almost all residents located within the contaminant plumes use city water for drinking and irrigation purposes.* In order to allow residential or other use of ground water from this system in the forseeable future an active remediation program must be initiated. Otherwise, the prohibition against drilling new wells must be extended until such time as natural attenuation alleviates the public health and environmental threat.

Lower Aquifer: The lower aquifer is separated from the upper by a relatively low permeability zone approximately 35 feet thick which generally provides a hydraulic separation

*Some well owners within the historical boundaries of the contaminant plumes have refused to stop using well water for certain functions, usually lawn or garden irrigation. Three wells are still used by the owners and families as a source of drinking water. All three of these wells are on the very edges of the contaminant plume, and the risk is not considered to be high. However, Champion International continues to attempt to convince the well owners to accept the buy-water option (September, 1986

ROD) to eliminate this potential exposure problem.

between the two systems. The lower aquifer ranges in depth from approximately 100 to 160 feet below ground surface. This system is less well defined than the upper aquifer but is thought to exhibit high transmissivities as well. Wood treating compounds are found in the deep aquifer in a dissolved state, but the problem is compounded by the presence of light and dense non-aqueous phase oils which provide a continuous source of new contaminants to the system. Because of the excellent hydraulic properties of the upper aquifer, no residential or irrigation wells are located in the lower aquifer downgradient of the site.

Therefore, there are three distinct major sub-actions at the Libby site which may be defined by media. This Record of Decision details the remedy selection process for the entire site as a single response action, but in fact the process used to select the feasible alternatives was conducted by the media of concern. A thorough explanation of the rationale for this approach and the complete analysis may be found in the Feasibility Study for Site Remediation.[4]

V. Summary of Site Characteristics

As discussed earlier, wood treating fluids and constituents are the contaminants of concern at the site. Contaminants are found in soils and sediments at several different locations including former waste pits, tank storage areas, and butt dip and treatment tank sites. The contaminants are the result of dumping of spent fluids, overflow of treatment tanks, and spills. The four different wood treating compounds used include creosote, pentachlorophenol, copper-chromium-arsenate salts, and a mixture of various compounds including creosote and penta. In addition, certain carrier fuels or oils were used with the treating compounds, and these have contributed primarily volatile organic contaminants to the environment. The remainder of this section will discuss first the characteristics of the contaminant compounds used, and then the extent of contamination in the soils and upper and lower aquifers.

Contaminant Characterization

Creosote: Creosote is a complex mixture of organic compounds produced from coal.[5] At least 200 compounds have been identified in creosote, although it is possible that several thousand different compounds could be isolated. Most of those are present in very small amounts. The major components of creosote are the neutral fraction polynuclear aromatic hydrocarbons (PAH). Other components include tar acids, such as phenols and cresols; tar bases, such as pyridenes and acridine; and the nitrogen containing polycyclic hydrocarbon compounds such as quinoline. Because creosote is a blend of coal distillation processes it does not have a definite composition, and physical properties, such as specific gravity and PAH content, may vary by manufacturer and/or by application (poles vs. railroad ties, etc.).

The PAHs are the primary components of creosote which are of concern at the Libby site. The PAHs have variable solubilities which decrease with increasing molecular weight, from about 34 ppm for napthalene to <1 ppb for benzo(g,h,i)-pyrene.[4] (This large difference in solubilities has important implications for treatment design.) The property of solubility can be used as a guide for adsorptive behavior. As aqueous solubility decreases, adsorption increases. Because of the low solubility of some of the PAHs, adsorption onto subsurface sediments has been a dominant process in control of their migration. The solubilities and adsorptive properties of PAHs together control the environmental mobility. It is expected that the lighter, more soluble compounds will have migrated further than the heavier compounds which will be adsorbed onto sediments in relatively greater concentrations. The PAH compounds are also considered non-volatile under ambient conditions, but this property varies considerably with molecular weight, with the heavier compounds generally less volatile or susceptible to move into the gaseous state.

Pentachlorophenol: The technical grade pentachlorophenol (penta or PCP) used for treating wood contains 85 to 90% penta. The remaining materials are 2,3,4,6-tetrachlorophenol, 4 to 8%; "higher chlorophenols," 2 to 6%; and dioxins 0.1%.[5] Other compounds are produced as contaminants during manufacture, including complex phenols, ethers, chlorinated dibenzofurans and chlorinated dibenzo-p-dioxins. The principal chlorodioxin and chlorodibenzofuran contaminants found in penta are those containing six to eight chlorines (hexa, hepta and octa).[5] The most toxic isomer, 2,3,7,8-tetrachlorodibenzo-p-dioxin, has not been detected in any analysis of soil, oil or ground water at the site.

Penta is a mild acid which ionizes in solution to form pentachlorophenate anion. The ionization is dependent upon pH of the environment, and its aqueous solubility may therefore vary greatly. Penta is volatile enough to be steam distilled, and the relatively high volatility, compared to other chlorinated organic compounds of low vapor pressure, can cause losses of penta from soils similar to those of the lightest PAH compounds.[5]

The dioxins and furans contained in penta display different physical characteristics. They generally have very low solubilities, in the part-per-trillion range, and they are more adsorptive than even the heaviest PAH compound. Vapor pressures for dioxins and furans are lower than the PAHs as well, and they are considered non-volatile at ambient conditions. The low solubility and high adsorption coefficients help to explain why dioxins and furans have not been encountered in ground water samples, without NAPL present, at Libby.

Copper-Chromium-Arsenate: A Copper-Chromium-Arsenate (CCA) salts solution was used to treat wood for a relatively short time during the late 1960s. The salt solution probably also contained fluoride and dinitrophenol. A fire retardant was also believed to have been used which contained zinc chloride, chromium, boric acid and ammonium sulfate. The primary contaminants of concern from these solutions appear to be zinc and arsenic in some ground water wells. Nickel and lead have been detected above background levels as well. (It should be noted that fuels or carrier oils may also have contributed metals to the soils and ground water.)

Other Compounds: Volatile organic compounds such as benzene and methylene chloride have been detected in ground water samples. These compounds are thought to have derived from the carrier fuels, oils or solvents used in the various treating processes. For instance, diesel fuel, which contains benzene, is commonly added to penta prior to butt dip operations. The volatiles are generally very soluble in ground water. For example, benzene has an aqueous solubility of 1,850 ppm at 25°C, more than one million times greater than dioxins. The volatiles are generally not easily adsorbed onto soils because of their high solubilities, but they have a much higher volatilization potential at ambient conditions.

Extent of Contamination

The following paragraphs describe the extent of contamination at the site in terms of contaminant concentrations, locations, migration routes, etc. Detailed analyses of site characteristics, including the extent of contamination, are available in documents contained within the administrative record, including the 1988 RI Report, the March 1986 Phase IV RI Report, and sampling data summaries from all historical site investigations.

Soils: Soil contamination at the site varies greatly, not only between source areas but also within source areas. Volatiles such as xylene have been detected, but in relatively small concentrations. Most of the very volatile compounds have probably migrated into the ground water or were volatilized during exposure to atmospheric conditions. Elevated levels of metals such as zinc and lead have been detected in some sampling locations but overall the concentrations are not of concern. (Because of the short time span during which metal salts treating compounds were used, it is possible that a discrete substrate horizon may be encountered during soils remediation which contains higher concentrations.)

The primary contaminants of concern in the soils and subsurface sediments are the PAHs, penta and to a lesser extent, dioxins. Table 1 lists a summary of contaminant concentrations detected in samples from test pits and borings from the waste pit area, the tank farm, and the treatment areas. Figure 5 depicts the sampling locations within the tank farm area, mineral spirits tank area, retort area, runoff collection ditch, butt dip treatment area, and waste pit area.

Measured soil PAH values ranged from non-detectable to per cent concentrations in the waste pit area at one depth. The waste pit area had the highest PAH soil concentrations of any of the treatment, storage or waste disposal areas. Measured PCP values ranged from non-detectable to over 2,700 ppm in the waste pit area, which also had the highest overall PCP concentrations of any of the waste areas. The highest concentrations of dioxins and furans are from the butt dip tank area (Table 2). The dioxin homologs most often detected, and in the highest concentrations, are octa and hepta. Sampling coverage for dioxins and furans at the site is not extensive. However, the results of the analyses conducted are consistent with data on dioxins and furans from other wood treating facilities, in both the homologs found and the relatively low concentrations.

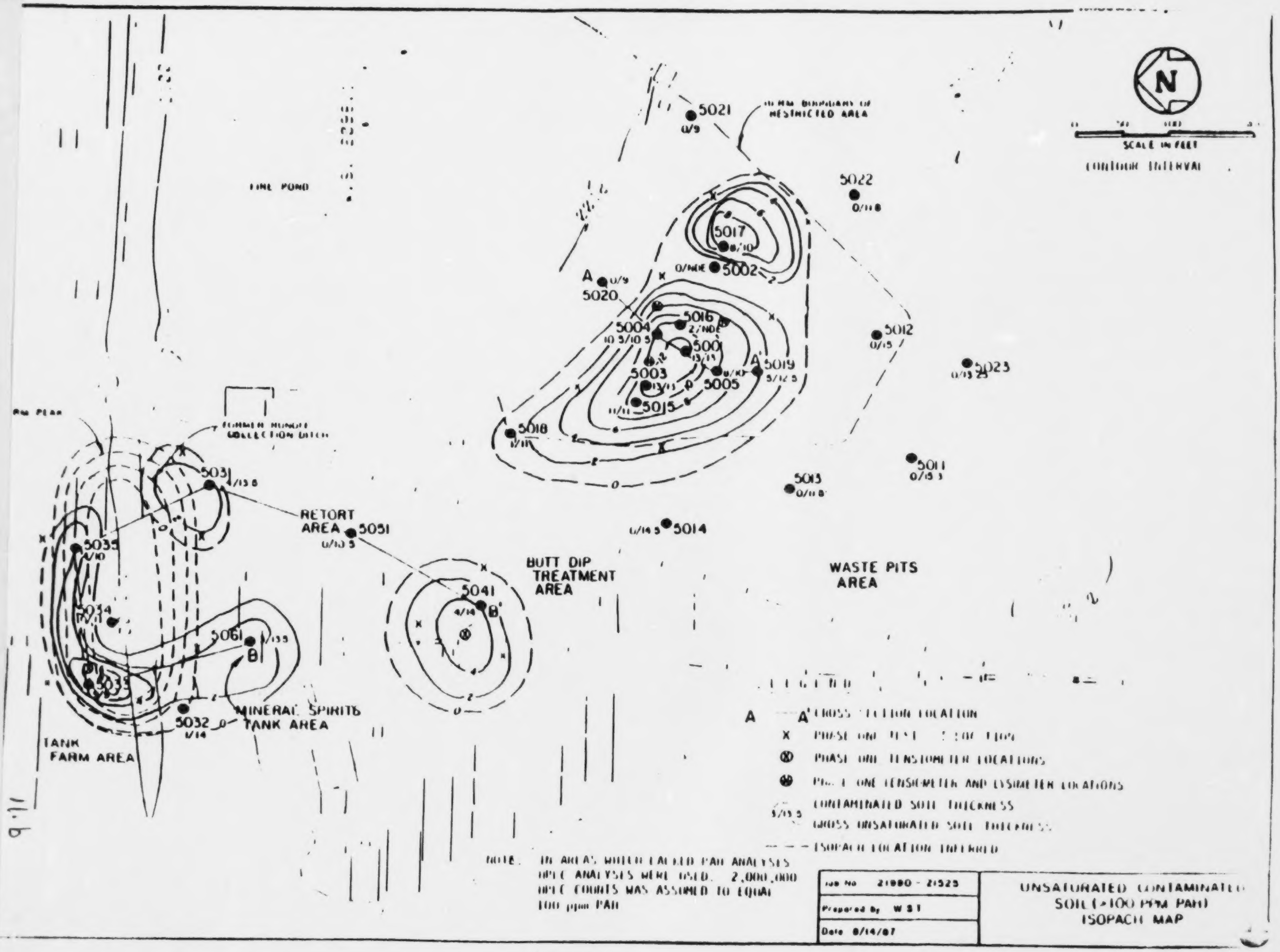
Overall, soil concentrations have been relatively well defined in a horizontal scale. Extensive samplings during the various investigations at the site have defined the limits of contamination around the known treatment, storage and disposal areas. Vertical extent of contamination is less well defined, for two reasons. Wood treating fluids have been migrating downward through the unsaturated zone and into the sediments of the upper aquifer. Sampling at depths well below the water table indicates the presence of contaminated sediments. The contaminants have therefore been able to migrate quickly through the highly porous soils and sediments underlying the waste areas. The second reason why the vertical extent is less well quantified is a problem of definition of the source areas. As described previously, many of the contaminant compounds adsorb readily onto solid matrices. Oils which have migrated with the ground water in a separate phase may ultimately adhere to sediments well within the water table and far from the original place of deposition. In this respect, those adsorbed contaminants are now a non-aqueous phase source of further aqueous contamination. This problem helps to explain why the division between soils or source cleanup and ground water remediation is not exact.

Upper Aquifer: The extent of contamination in the upper aquifer has been well delimited. The primary contaminants of concern in the ground water are the PAH compounds and penta. Certain metals, such as arsenic and zinc, have been detected above background, but arsenic (above background, below Maximum

TABLE 1

CONTAMINANT CONCENTRATIONS AND SOIL SOURCE AREAS DESIGN CRITERIA

	Design Volumes (yd³)				Noncarcinogenic[1]	Carcinogenic[2]	Volatile Organic Compounds (mg/kg)			Metals (mg/kg)		
	Total Volumes	Soil	Rocks	PCP (mg/kg)	PAHs (mg/kg)	PAHs (mg/kg)	Benzene	Toluene	Xylene	As	Cr	Pb
Waste Pit Area	21,580	17,230	4,310									
- Number of Samples				32	77	77	15	15	15	15	15	15
- Number of Samples Above Detection				27	50	50	0	4	8	15	15	15
- Minimum Concentration				1.0	2.0	.531	-	.011	0.06	2.0	7	5.0
- Maximum Concentration				2700	26555.0	7304.0	-	0.11	10.60	44.0	28	50.0
- Geometric Means				35.71	891.5	164.4	-	.024	0.72	7.21	9.7	11.45
Tank Farm	7,540	6,030	1,150									
- Number of Samples				5	27	27	5	5	5	5	5	5
- Number of Samples Above Detection				5	9	7	1	1	2	5	5	5
- Minimum Concentration				4.3	.133	1.302	.36	.35	1.02	6	9	5
- Maximum Concentration				16	232.0	111.0	.36	.35	1.35	19	29	10.0
- Geometric Means				6.4	10.5	10.1	.36	.35	1.17	10.3	12.42	7.10
Butt Dip Area	870	640	230									
Single Data Point				280	35.8*	21.7**	ND	1.1	0.13	7.0	9.0	12
All Areas	30,000	24,000	6,000									


N
SCALE IN FEET
CONTOUR INTERVAL
FIRE POND
5021
0/9
5022
0/11 8
5017
8/10
0/NDE
5002
A
0/9
5020
5016
2/NDE
5004
10 5/10 5
5001
13/13
5003
13/13
5005
5019
5/12 5
A'
5015
11/11
5018
0/11
5012
0/15
5023
0/13 25
5011
0/15 5
5013
0/11 8
0/14 5
5014
WASTE PITS AREA
FORMER RUNOFF COLLECTION DITCH
5031
4/13 8
RETORT AREA
5051
0/10 5
BUTT DIP TREATMENT AREA
5041
4/14
B'
5035
1/10
5034
5061
4/13 5
B
5033
5032
1/14
MINERAL SPIRITS TANK AREA
TANK FARM AREA
LEGEND
A — A' CROSS SECTION LOCATION
X PHASE ONE TEST LOCATION
⊗ PHASE ONE TENSIOMETER LOCATIONS
⊕ PHASE ONE TENSIOMETER AND LYSIMETER LOCATIONS
5/13 5 CONTAMINATED SOIL THICKNESS / GROSS UNSATURATED SOIL THICKNESS
- - - ISOPACH LOCATION INFERRED

NOTE. IN AREAS WHERE LACKED PAH ANALYSES HPLC ANALYSES WERE USED. 2,000,000 HPLC COUNTS WAS ASSUMED TO EQUAL 100 ppm PAH

Job No	21980 - 21525
Prepared by	W S T
Date	8/14/87

UNSATURATED CONTAMINATED SOIL (>100 PPM PAH) ISOPACH MAP

Figure 5

11.C

TABLE 2

POLYCHLORINATED FURANS AND DIOXINS (PPB) IN SELECTED SAMPLES[1,2]

	Soil							Oil		
	Waste Pit	Waste Pit	Waste Pit	Tank Farm	Butt Dip Tank	Butt Dip Tank	Average[4] Soil Concentration			Average Oil Concentration
Sample Number	Soil[3] Sample	5015	5017	5033	5041	Soil Sample[3]		3012-3	6004	
Furans										
tetra	<0.084	<0.017	<0.020	<0.0045	<0.026	<0.0091	<0.031	<2.4	<1.4	<1.9
penta	0.64	3.1	<0.021	1.0	8.9	<0.33	1.29	71.0	34.6	52.8
hexa	23.0	25.9	4.2	11.3	196.0	11.0	18.67	148	1760	954
hepta	110.0	160.0	42.9	88.6	1220.0	72.0	116.6	145	1190	667
octa	150.0	111.0	37.8	74.2	593.0	100.0	100.4	3470	86300	44,885
Dioxins										
tetra	<0.15	<0.020	<0.017	<0.0075	<0.029	<0.0093	<0.047	<1.6	<0.36	<0.98
penta	<0.31	<0.065	<0.10	<0.037	15.6	<0.14	0.36	<6.5	<0.45	<3.5
hexa	8.4	2.4	2.5	3.0	194.0	7.1	6.94	16.4	662	339
hepta	200.0	121.0	97.2	142.0	4,830.0	190.0	210.8	1,450	11,100	6,275
octa	840.0	282.0	226.0	459.0	1,700.0	870.0	476.7	26,100	42,800	34,450

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[1] From "June 1985 Water Quality Report, Ground Water Contamination Site, Libby, Montana" Vol. 1 - Summary, WCC, January 1986

[2] From "Phase IV, Step 3 Remedial Investigations Report, Ground Water Contamination Site, Libby, Montana" Vol. 1 - WCC, April 1988

[3] Sampled during July 1988

[4] Average Concentration Is Calculated By The Weighted Average Based On Mass Of Contaminated Soil From The Three Areas

Contaminant Level (MCL) in Safe Drinking Water Act) appears to be limited to wells close to the source and some isolated off-site wells near the Champion property line. Certain volatile organic compounds, such as benzene and methylene chloride, occur in the ground water, but attempts to predict migration behavior have been unsuccessful. For instance, benzene concentrations <50 ppb have been measured at several locations within the PAH plume, but these are not consistent. Volatile organics may be the result of source oil presence in the aquifers which continue to contribute to ground water contamination. Dioxins and furans have not been detected in ground water samples which do not contain a non-aqueous phase component.

Figures 6, 7, and 8 depict isoconcentrations of pentachlorophenol, non-carcinogenic PAHs and carcinogenic (including suspected) PAHs in the upper aquifer. All of the plumes presented in these figures reflect the area ground water flow trending north to northwest. Highest concentrations of contaminants are found immediately below the waste disposal areas. For PAHs and penta the concentration gradients are quite steep with higher concentrations near the source. Penta concentrations decrease rapidly away from the source, and near the property boundary concentrations are approximately 100 ppb. PAH concentration plots are similar. Concentrations of PAH compounds vary from hundreds of parts per million near the waste pit area to hundreds of parts per billion near the Champion property boundary. All of the plots show that aqueous phase contamination in the ground water has migrated some distance from the source areas. The fact that contaminants have not migrated further in the ground water, given the system's high transmissivity and the length of time since contaminants were probably introduced to the system, is somewhat surprising. However, diffusion, microbiological decay and contaminant adsorption onto sediments has probably controlled the lateral extent of contamination.

Lower Aquifer: There are fewer sampling locations in the lower aquifer, but dissolved contaminant distribution is believed to be similar to the upper aquifer. Contaminant plumes extend off site; in fact, penta concentrations may be even greater in some of the deep aquifer wells than in the upper aquifer. Well 6007, which is northwest and outside of the upper aquifer penta plume, has revealed penta concentrations in excess of 1,100 ppb on more than one sampling episode.

Definition of the lower aquifer and contamination in the lower aquifer has been complicated by the presence of non-aqueous phase wood treating oils in some locations. Wood treating fluids may be lighter or denser than water and quite viscous. Oils which have not been adsorbed onto soils or broken down by bacterial activity have migrated into water bearing formations. Once into the saturated zone, dense NAPLs continue to respond to

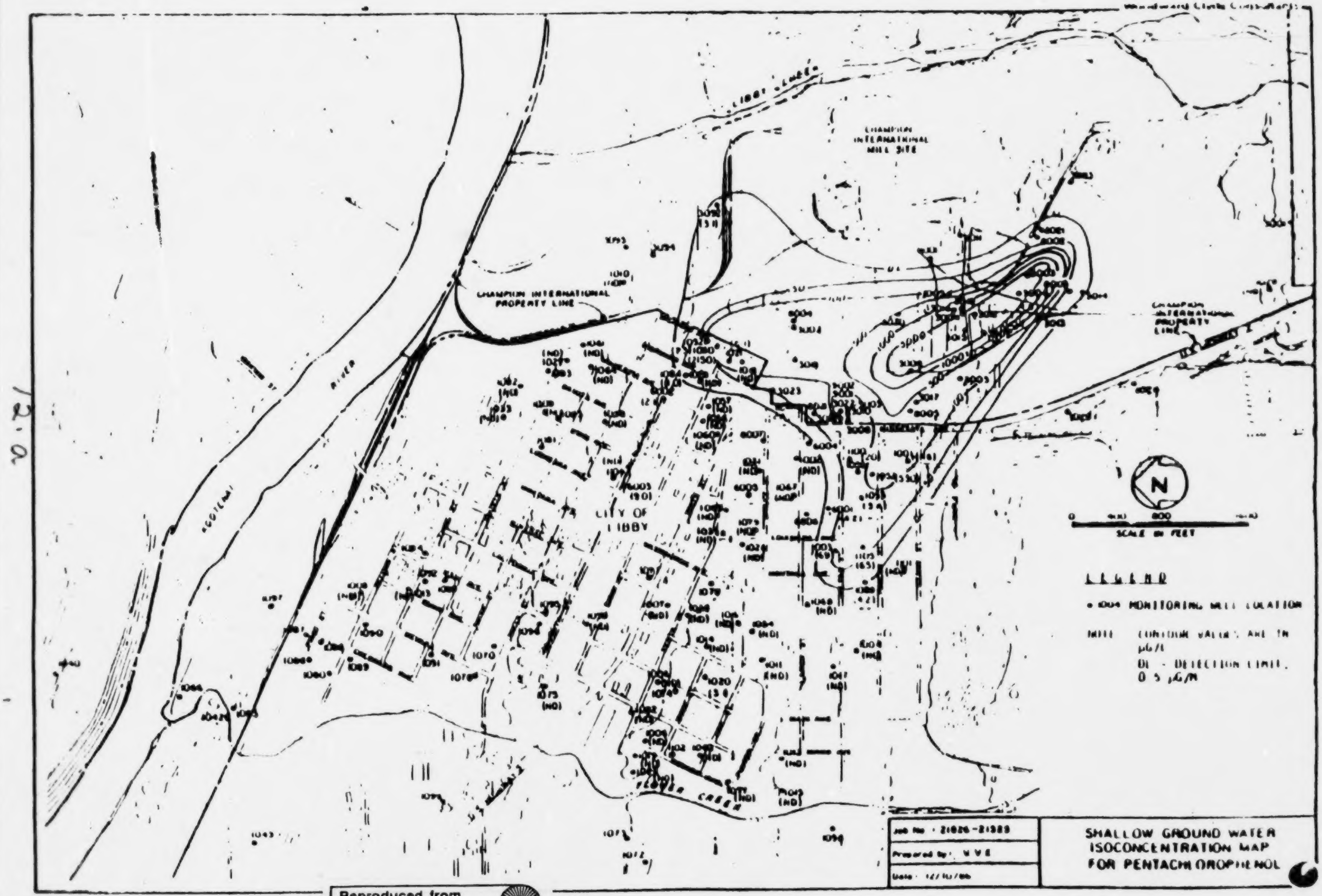
Woodward-Clyde Consultants
LIBBY CREEK
CHAMPION INTERNATIONAL MILL SITE
CHAMPION INTERNATIONAL PROPERTY LINE
CHAMPION INTERNATIONAL PROPERTY LINE
CITY OF LIBBY
KOOTENAI RIVER
FLOWER CREEK
1000
5000
N
0 400 800 1600
SCALE IN FEET
LEGEND
• 1004 MONITORING WELL LOCATION
NOTE CONTOUR VALUES ARE IN µG/L
DL - DETECTION LIMIT, 0.5 µG/M
Job No : 21026-21389
Prepared by : WVE
Date : 12/16/86
SHALLOW GROUND WATER ISOCONCENTRATION MAP FOR PENTACHLOROPHENOL

Figure 6

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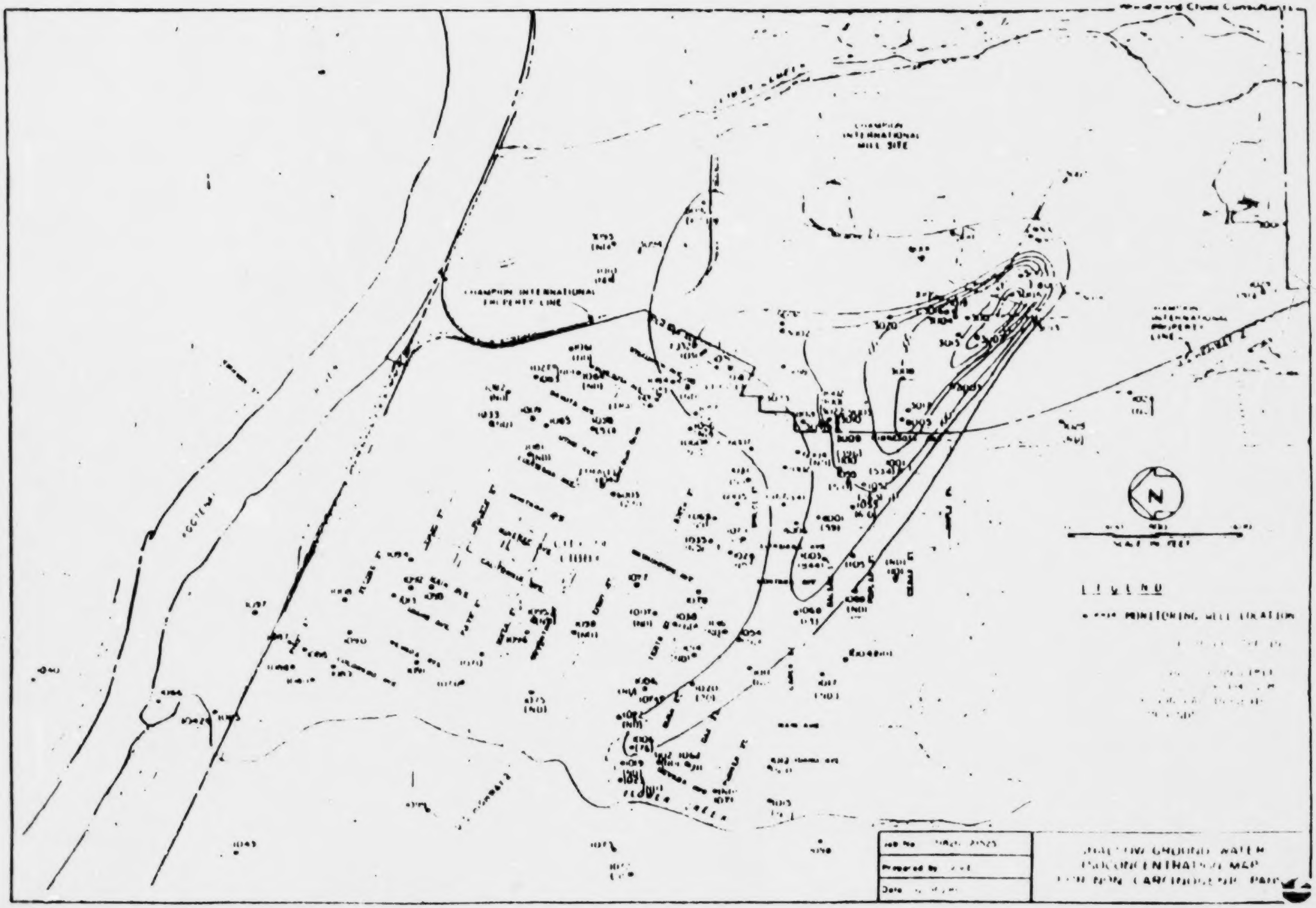
CHAMPION INTERNATIONAL MILL SITE
CHAMPION INTERNATIONAL PROPERTY LINE
N
SCALE IN FEET
LEGEND
MONITORING WELL LOCATION
Job No.
Prepared By
Date
SHALLOW GROUND WATER
ISOCONCENTRATION MAP
FOR NON-CARCINOGENIC PAHs

Figure 7

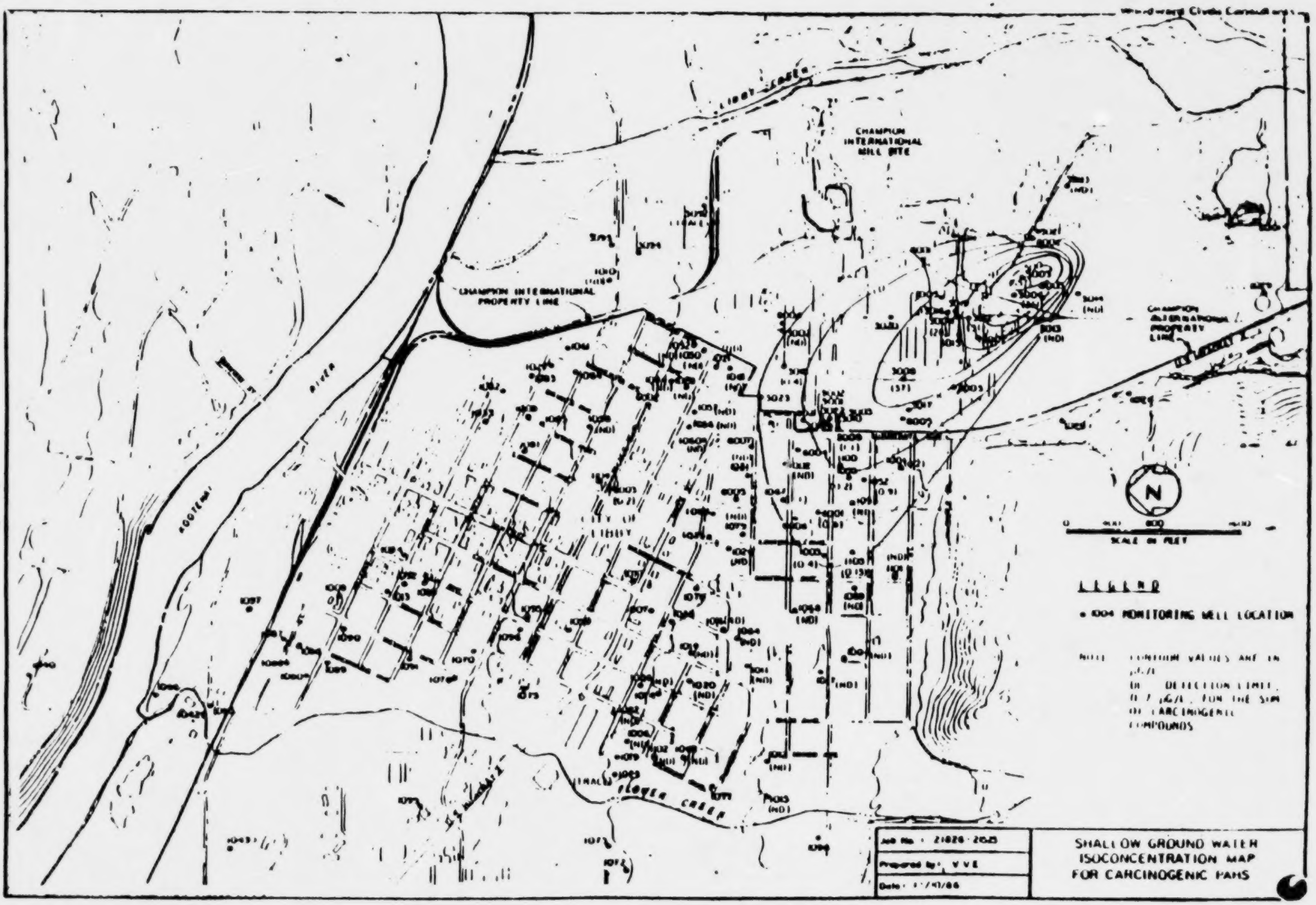
Woodward-Clyde Consultants
CHAMPION INTERNATIONAL MILL SITE
CHAMPION INTERNATIONAL PROPERTY LINE
CHAMPION INTERNATIONAL PROPERTY LINE
KOOTENAI RIVER
CITY OF LIBBY
FLOWER CREEK
US HIGHWAY 2
(ND)
(37)
N
0
400
800
1600
SCALE IN FEET
LEGEND
• 1004 MONITORING WELL LOCATION
NOTE: CONTOUR VALUES ARE IN µG/L
ND DETECTION LIMIT, 0.7 µG/L, FOR THE SUM OF CARCINOGENIC COMPOUNDS
Job No.: 21026-2025
Prepared by: VVE
Date: 1'/41/86
SHALLOW GROUND WATER ISOCONCENTRATION MAP FOR CARCINOGENIC PAHS

Figure 8

12.C

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gravitational force and move, via capillary action, as stringers which are limited by encountering finer grained, impermeable materials. At Libby, these impermeable materials tend to occur in discontinuous lenses. If the slope of the lens is not sufficiently steep the oil may stop migrating. Because the lenses are discontinuous, in a very complicated mixture of fluvial and glaciofluvial constructed hydrogeology, the locations of these oils have been unpredictable. The result is that free phase heavy oils continue to reside in the lower aquifer, acting as source materials and continuously providing dissolved contaminant loading to the ground water.

VI. Summary of Site Risks

A baseline human health endangerment assessment was prepared in support of the Feasibility Study for the 1st operable unit.[6] This initial endangerment assessment evaluated only the current and future risks to persons associated with contaminated ground water in the upper aquifer. The feasibility study report[4] upon which this Record of Decision is based updates that baseline endangerment assessment and expands upon it to include a human health and environmental impact evaluation for all potential exposure pathways (See Appendix D, December 1988 FS Report). The results of those evaluations are presented below.

Indicator Compounds

Thirty-five different organic and inorganic compounds have been detected in private ground water wells near the Libby site during the course of site investigations. Table 3 lists most of these compounds and presents the range and geometric mean concentrations for each compound detected. The geometric mean concentration was used as the long term concentration to determine the chronic daily intake for each contaminant. The compounds listed in the table were subjected to the indicator chemical selection process as outlined in the Superfund Public Health Evaluation Manual[7]. The procedure utilized evaluates and ranks the chemicals in terms of carcinogenic potency and toxicity. Table 4 presents the results of the indicator selection process along with the respective chronic and/or subchronic acceptable intake concentrations and the carcinogenic potency factor (CPF) for those compounds identified as carcinogens. Table 5 presents the indicator score values for the compounds, distinguishing between potential carcinogen and non-carcinogen values where applicable. Some compounds have been retained as indicators for reasons other than a procedural determination. For instance, the compound may be a suspected carcinogen as are some PAHs or, in the case of pentachlorophenol, the compound is ubiquitous throughout contaminated zones.

Note that the benzo(a)pyrene CPF has been used to evaluate health risks for all known or suspected carcinogenic polyaromatic

TABLE 3

CONTAMINANTS DETECTED IN PRIVATE GROUND-WATER WELLS

Chemical	Range (μg/l)	Geometric Mean (μg/l)[1]	No. of Samples Above Detection
Arsenic	5 - 5	-[2]	2
Zinc	190 - 2010	642.60	12
Copper	23 - 160	52.70	10
Chromium III [3]	6 - 17	8.67	5
Lead	30 - 35	32.40	2
Nickel	7 - 79	23.80	4
Pentachlorophenol	2 - 3200	52.12	23
Naphthalene	2 - 500	34.06	21
Acenaphthylene	1 - 200	12.79	12
Acenaphthene	3 - 100	28.58	20
Fluorene	0.10 - 48	6.97	31
Phenanthrene	0.08 - 27	3.96	22
Anthracene	0.02 - 4	0.57	16
Fluoranthene	0.10 - 1.10	0.27	10
Pyrene	0.14 - 0.74	0.27	6
Chrysene	0.07 - 5	0.24	4
Benzo(a)anthracene	0.09 - 0.09	0.09	1
1-methyl napthalene	5.4 - 270	71.18	7
2-methyl napthalene	4.90 - 78	32.53	7
Benzene	0.60 - 20	3.28	15
Toluene	0.10 - 51	1.81	13
Total Xylene	2 - 109	16.32	20
Methylene Chloride	0.80 - 16	2.53	6
2-Butanone	3.1 - 230	13.54	6
Ethylbenzene	0.15 - 19	2.50	10
1,1-dichloroethane	0.5 - 0.6	0.55	2
Tetrachloroethylene	0.5 - 1.6	1.06	4
1,1,2-Trichloro-2,2,1-Trifluoroethane	2.60 - 16	6.45	2

[1] Only values measured above detection were used in calculating the geometric mean.

[2] No geometric mean concentration is calculated since this compound was detected in only one well during one sampling period (July 1985) and the concentration detected equals the detection limit.

[3] All Chromium is assumed to be trivalent.

* Compounds detected in NAPL in aqueous samples are not necessarily included.

TABLE 1

CRITICAL TOXICITY FACTORS*

Chemical	Acceptable Intake for Subchronic Exposure (AIS)⁽¹⁾ (μg/kg/day)	Acceptable Intake for Chronic Exposure (AIC)⁽¹⁾ (μg/kg/day)	Carcinogenic Potency Factor⁽²⁾ (μg/kg/day)$^{-1}$
Arsenic	--	--	1.5 x 10^{-2}
Benzo(a)anthracene	--	--	1.15 x 10^{-2} (3)
Chrysene	--	--	1.15 x 10^{-2} (3)
Fluoranthene	--	--	1.15 x 10^{-2} (3)
Pyrene	--	--	1.15 x 10^{-2} (3)
Benzene	--	--	5.2 x 10^{-5}
Nickel	20	10	--
Lead	--	1.4	--
Copper	37	37	--
Zinc	210	210	--
2-Butanone	--	50	--
Ethylbenzene	970	100	--
Toluene	430	300	--
Pentachlorophenol	30(T)	30	--
Chromium III	14,000	1,000	--
Xylenes (total)	100	10	--
Methylene chloride	--	60	7.5 x 10^{-6}
1,1-dichloroethane	1,200	120	--
Tetrachloroethylene	--	20	5.1 x 10^{-5}
1,1,2-Trichloro-2,2,1-Trifluoroethane	--	30,000	--

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* All values and factors are taken from the Superfund Public Health Evaluation Manual, October 1986, Exhibits C-4 and C-6. These values are not adjusted for site specific conditions.

(T) Indicates that the AIS is based on teratogenic or fetotoxic effects.

(1) These values are based on quantitative information from toxicological research. AIS values are based on 10- to 90-day animal studies and AIC values are based on long-term animal studies.

(2) The lifetime cancer risk based on a 95-percent confidence limit.

(3) Carcinogenic Potency Factor is based on Benzo(a)pyrene.

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TABLE 5

EVALUATION OF EXPOSURE FACTORS AND FINAL CHEMICAL SELECTION

	Indicator Score Value (1)		Tentative Ranking (1)		Water Solubility		
Chemical	PC	NC	PC	NC	(mg/1)	K_{oc} (2)	IC (3)
Arsenic		* 0.09		4			+
Benzene	0.0000252	0.0023	1	6	1.85×10^3	60	+
Nickel		0.3365		1			+
Lead		0.0313		5			+
Copper		0.1142		3			+
Zinc		0.2151		2			+
2-Butanone		0.0018		7	2.7×10^5	4.5	+
Ethylbenzene		.0002		9	1.52×10^2	165	+
Toluene		.0003		8	5.35×10^2	206	+
Tetrachloroethylene	0.0000093		2	12			(+)
Methylene Chloride		0.000014		11			(+)
1,1-Dichloroethane		0.00002		10			(+)
Pentachlorophenol							(+)
Chromium III							(+)
Xylenes (total)							(+)
Fluoranthene							(+)
Pyrene							(+)
Chrysene							(+)
Benzo(a)anthracene							(+)
1,1,2-Trichloro-2,2,1-Trifluoroethane							(+)

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(1) Indicator scores from Tables D.1-4 and D.1-5
PC = Potential Carcinogen
NC = Non-Carcinogen

(2) K_{oc} is the organic carbon partition coefficient and is the measure of the relative sorption for organics

(3) + indicates selection of chemical as an indicator based on EPA recommended procedure and (+) indicates other chemicals selected as indicator chemicals

* Should be listed as carcinogen.

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hydrocarbons in this study. It should also be pointed out that the geometric mean concentration for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is used in risk evaluations for soils, whereas dioxins and furans were not detected in ground water in the dissolved state and therefore are not used as ground water indicator compounds. Finally, no samples collected at Libby detected 2,3,7,8-TCDD. Instead, higher chlorinated, 2,3,7,8-dibenzo-p-dioxins and dibenzofurans (hexa, hepta and octa) concentrations, and other dioxin and furan isomers, have been converted to 2,3,7,8-TCDD using EPA equivalency calculations (EPA/625-3-87-012).

Toxicity Assessment: The indicator compounds should represent the most toxic, mobile and/or persistent hazardous substances associated with the site. Toxicological research on animals has provided much of the information with which the risk evaluations are made. The following summarizes some of the toxicity effects of the indicator compounds:

- Ingestion of certain indicator compounds has the potential to cause damage to organs. Benzene, copper and pentachlorophenol can cause liver and kidney damage.
- Inhalation of certain indicator compounds may cause adverse health effects. Many PAH compounds may be absorbed into the body through the lungs, causing problems similar to those resulting from ingestion. Inhalation of arsenic can cause lung cancer. Most of the more volatile compounds can irritate the eyes and upper respiratory tract.
- Dermal absorption of some compounds leads to similar effects as ingestion. Contact with pentachlorophenol, benzene and PAHs may cause dermatitis.
- Many of the indicator compounds, such as arsenic and benzene, are known or suspected carcinogens. Various compounds are linked to mutagenic or reproductive effects. Some lighter molecular weight PAHs are considered possible initiators of carcinogenic effects.

Exposure Pathways

Soils and Source Materials: The feasibility study[4] evaluated three different potential projected future exposure scenarios and determined the risks associated with each scenario. The procedures and assumptions used in this evaluation were taken from the Superfund Public Health Evaluation Manual, although more appropriate, specific assumptions were used for given site circumstances. The following exposure pathways were identified as being of potential concern:

Residential Scenario: Assumes that at some future date one or more residences are constructed on the site.

- Ingestion of contaminated soils
- Inhalation of contaminated soils
- Dermal absorption of contaminated soils

Industrial Scenario: Assumes that the site will continue to be used as an industrial facility.

- Inhalation of contaminated soils
- Dermal absorption of contaminated soils

Construction Worker Scenario: Assumes that new building construction takes place on site and workers are exposed to contaminated soils.

- Oral exposure (ingestion) to contaminated soils
- Inhalation of contaminated soils
- Dermal absorption of contaminated soils

Upper Aquifer Ground Water: Exposure pathways for off-site private wells were developed in support of the 1st operable unit Record of Decision, which authorized an alternate water supply for those persons potentially exposed to contaminated ground water from private wells. Dermal absorption or inhalation of volatile organics while showering or bathing was evaluated and found not to be a significant exposure pathway. The following exposure pathways, also applicable to this study, were identified as being of potential concern:

- Ingestion of contaminated drinking water
- Child ingestion of soil contaminated by ground water irrigation
- Ingestion of home garden produce irrigated with contaminated ground water

Lower Aquifer Ground Water: There are no known domestic wells in use which are completed in the lower aquifer in this area, nor are there likely to be in the near future since the city of Libby has enacted a prohibition on the installation of ground water wells within the city limits. However, an analysis of potential human health impacts associated with contamination in the lower aquifer was conducted under a conservative, no-action scenario whereby a domestic-use well would be installed at some time in the future. Dermal absorption or inhalation of volatile organics while showering or bathing was determined to not be a significant exposure pathway. The following exposure pathways were identified as being of potential concern:

- Ingestion of contaminated drinking water
- Child ingestion of soil contaminated by ground water irrigation
- Ingestion of home garden produce irrigated with contaminated ground water

Risk Characterization: Soils and Source Materials

Potential current human health risks posed by contaminated soils have been minimized. Clean fill was placed over the contaminated soils during the dismantling of the wood treating facilities and access to the mill is controlled. Employees engaged in investigation activities and pilot testing of remediation alternatives follow safety procedures to reduce the potential for inhalation, ingestion or dermal absorption of contaminants.

As noted earlier, three potential projected future exposure scenarios are considered in evaluating the potential human health risks posed by a no-action scenario. The results of these are described below. Table 6 provides a summary of the calculated risks for each scenario.

Residential Scenario: The carcinogenic risks for each on-site area range from approximately 9.6 x 10^{-3} to 8.1 x 10^{-4} assuming a maximum exposed individual is exposed to the calculated geometric mean concentration. The combined area carcinogenic risk is calculated to be 3.8 x 10^{-3}. The majority (>50%) of carcinogenic risk for soils found in the waste pit and tank farm areas is attributable to suspected carcinogenic PAH compounds. The carcinogenic risk for soil samples from the butt dip area is primarily attributable to the 2,3,7,8-TCDD equivalency (60%). Hazard indices for each area are below unity, indicating no potential non-carcinogenic risk.

Industrial Scenario: The total carcinogenic risks for each on-site area range from approximately 5.7 x 10^{-4} for the butt dip area to 8.2 x 10^{-5} for the tank farm area assuming a maximum exposed individual is exposed to the calculated geometric mean concentration. The combined area carcinogenic risk is calculated to be 1.75 x 10^{-4}. For dermal exposure in the tank farm and dermal and inhalation exposure in the waste pit area, the majority of the carcinogenic risk is attributable to suspected

TABLE 6
SUMMARY OF HEALTH RISKS FOR EACH LOCATION AND SCENARIO

SCENARIO	POTENTIAL CARCINOGENIC RISK				NONCARCINOGENIC HAZARD INDICES			
	Waste Pit	Tank Farm	Butt Dip	All Areas	Waste Pit	Tank Farm	Butt Dip	All Areas
Residential	2.82×10^{-4}	4.05×10^{-5}	4.81×10^{-4}	1.92×10^{-4}	7.72×10^{-4}	4.64×10^{-4}	1.38×10^{-3}	6.88×10^{-4}
	(5.64×10^{-3})	(8.10×10^{-4})	(9.62×10^{-3})	(3.84×10^{-3})	(1.54×10^{-2})	(9.28×10^{-2})	(2.76×10^{-2})	(1.38×10^{-2})
Industrial								
Dermal	9.04×10^{-6}	1.68×10^{-6}	2.00×10^{-5}	7.97×10^{-6}	3.21×10^{-5}	1.92×10^{-5}	5.81×10^{-5}	2.86×10^{-5}
	(1.81×10^{-4})	(3.36×10^{-5})	(4.00×10^{-4})	(1.59×10^{-4})	(6.42×10^{-4})	(3.84×10^{-4})	(1.16×10^{-3})	(5.72×10^{-4})
Inhalation	9.30×10^{-7}	3.35×10^{-7}	8.46×10^{-6}	7.80×10^{-7}	1.89×10^{-5}	1.42×10^{-5}	1.83×10^{-5}	1.75×10^{-5}
	(1.86×10^{-5})	(6.70×10^{-6})	(1.69×10^{-4})	(1.56×10^{-5})	(3.78×10^{-4})	(2.84×10^{-4})	(3.66×10^{-4})	(3.50×10^{-4})
Total	9.97×10^{-6}	2.02×10^{-6}	2.84×10^{-5}	8.75×10^{-6}	5.10×10^{-5}	3.34×10^{-5}	7.64×10^{-5}	4.61×10^{-5}
	(1.99×10^{-4})	(8.20×10^{-5})	(5.68×10^{-4})	(1.75×10^{-4})	(1.02×10^{-3})	(6.68×10^{-4})	(1.53×10^{-5})	(9.22×10^{-4})
Construction Worker								
Oral	2.35×10^{-5}	4.21×10^{-6}	4.94×10^{-5}	1.95×10^{-5}	1.43×10^{-2}	7.43×10^{-3}	6.81×10^{-2}	1.26×10^{-2}
Dermal	2.60×10^{-6}	4.62×10^{-7}	5.53×10^{-4}	2.20×10^{-6}	1.61×10^{-3}	8.30×10^{-4}	7.65×10^{-3}	1.42×10^{-3}
Inhalation	2.23×10^{-7}	7.90×10^{-8}	2.00×10^{-7}	1.84×10^{-7}	7.28×10^{-5}	8.18×10^{-5}	5.78×10^{-5}	7.40×10^{-5}
Total	2.63×10^{-5}	4.75×10^{-6}	5.51×10^{-4}	2.19×10^{-5}	1.60×10^{-2}	8.34×10^{-3}	7.58×10^{-2}	1.41×10^{-2}

Note: Values in parentheses indicate the risk estimated for the Maximum Exposed Individual (MEI) assumed to be exposed to 100% of the contamination (geometric) rather than 5%. For the construction worker scenario, only 100% mean contamination exposure (geometric) was assumed.

16.a

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carcinogenic PAH compounds. The carcinogenic risk for soil samples from the butt dip area is primarily attributable to the 2,3,7,8-TCDD equivalency (60%, one sample). For inhalation exposure to tank farm soils 69% of the carcinogenic risk is attributable to arsenic. The higher arsenic inhalation risk for the tank farm is due to slightly higher arsenic concentrations in tank farm soils and a greater potency factor for arsenic inhalation compared to PAH compound inhalation. However, the risk due to inhalation exposure overall is small, 3.35×10^{-7}. Hazard indices for each area are below unity, indicating no potential non-carcinogenic risk.

Construction Worker Scenario: Total carcinogenic risks for each on-site area range from approximately 5.5×10^{-4} to 4.8×10^{-6} assuming a maximum exposed individual. The combined area carcinogenic risk is calculated to be 2.19×10^{-5}. For oral, dermal and inhalation exposure in the waste pit area, and oral and dermal exposure in the tank farm area, the majority of the risk stems from carcinogenic PAH compounds. Risk due to ingestion of butt dip soils is associated primarily with 2,3,7,8-TCDD equivalency (76%, one sample). Dermal exposure risk in the butt dip area is also primarily a result of 2,3,7,8-TCDD equivalency, again based on one sample. Seventy five percent of the risk associated with inhalation exposure in the tank farm area soils is due to arsenic exposure. Finally, hazard indices for each area as well as total hazard indices are below unity, indicating no potential non-carcinogenic risk.

It should be noted that the risks due to ingestion and dermal exposure of soils from the butt dip area have been driven primarily by the 2,3,7,8-TCDD equivalency concentration of one sample. Other samples collected at the Libby site have contained dioxins and furans, but in typically lesser concentrations than the butt dip area. More samples have recently been collected from the butt dip and waste pit areas for dioxin/furan analyses; results are consistent with the data used in the risk assessment evaluations.

*Environmental Risks**: Soils and Source Areas*

Source controls already in place at the site effectively reduce the environmental risks associated with contaminated soils. Water and sediment samples taken in ponds on site and in the surrounding creeks and rivers do not indicate the presence of contamination. A continued environmental threat is the potential for further leaching of contaminants from source areas into the area ground water.

*Risk Characterization**: Ground Water, Upper Aquifer*

A summary of the carcinogenic and noncarcinogenic risks for all private, off-site wells associated with the three different

TABLE 7

SUMMARY OF HAZARD INDICES AND CARCINOGENIC RISK FOR OFF-SITE PRIVATE WELLS

UPPER AQUIFER - BASELINE PUBLIC HEALTH EVALUATION

	Total Subchronic Hazard Index[1]	Total Subchronic Hazard Index for Fetotoxic Effects	Total Chronic Hazard Index[1]	Total Carcinogenic Risk
Ground-water ingestion	0.5533	3.1	0.9797	3.0×10^{-4}[3]
Ingestion of soil by children	--	--	--	1.3×10^{-4}[2]
Ingestion of vegetables irrigated with contaminated ground water	--	--	--	3.7×10^{-7} to 3.1×10^{-6}[2]

-- Risk analysis does not apply to this exposure scenario.

[1] A hazard index value of greater than 1.0 indicates a potential human health hazard.

[2] Risk attributed to suspected carcinogenic PAH compounds.

[3] Risk attributed to benzene, methylene chloride, and suspected carcinogenic PAH compounds.

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ground water exposure pathways is presented in Table 7. The greatest carcinogenic risks are posed by potential exposure to the suspected carcinogenic PAH compounds by drinking of ground water (3.0×10^{-4}) and ingestion of soils irrigated with ground water (1.3×10^{-4}). A range of risks is provided for the ingestion of garden vegetables irrigated with contaminated ground water (3.1×10^{-6} to 3.7×10^{-7}). Total carcinogenic risk associated with cumulative exposure under this scenario is estimated to be 4.3×10^{-4}.

Chronic and subchronic (short term exposure) hazard indices have been determined by comparing the acceptable concentration of a compound which produces toxic effects to the actual concentration an individual may be exposed to. If a hazard index value (actual intake concentration divided by the acceptable value) exceeds one, a potential health risk may be assumed. The subchronic hazard index for fetotoxic effects resulting from penta exposure is 3.1, indicating a potential health risk. The total chronic hazard index is extremely close to one.

Two other risk evaluations were performed, one for receptors for the group of wells located within the current plume of contamination, and another addressing receptors for only the four individual wells within the current plume of contamination and owned by persons not currently connected to the city water system. The potential risks associated with these two evaluations are less than the risks calculated for all off-site wells because of the assumptions used in modeling. Calculations used for all off-site wells are based on potential concentrations in the future, whereas concentrations used to determine risks for the latter two evaluations are based on mean concentrations within the plume and for the four wells, respectively. (See Table 8)

A no-action human health evaluation was conducted using data for the four wells within the contaminant plume, currently not using municipal water for irrigation, and potentially using well water for consumption. (At present, only one private well is known to use contaminated ground water for consumption, despite repeated attempts to convince the owner not to do so. The well is located very near the low concentration edge of the upper aquifer plume.) Concentrations used in determining the risks were based on present concentration, and projected for 10 year and 30 year conditions. Table 9 presents the present and future risks posed by ingestion of contaminated ground water at these four locations. Risks were calculated assuming a 70-kg adult drinks 2 liters of water a day for a lifetime carcinogenic potency factor of 0.0115 $(\mathrm{ug/kg/day})^{-1}$. Present risk is as high as 3.24×10^{-4} and the value increases in the future as plume concentrations in the vicinity of the wells get higher.

TABLE 8

SUMMARY OF HAZARD INDICES AND CARCINOGENIC RISK FOR THE CONTAMINANT PLUMES

UPPER AQUIFER - BASELINE PUBLIC HEALTH EVALUATION

	Total Subchronic Hazard Index[1]	Total Subchronic Hazard Index for Fetotoxic Effects	Total Chronic Hazard Index[1]	Total Carcinogenic Risk
Ground-water ingestion	--	3.1	0.0201	5.58×10^{-5}[3]
Ingestion of soil by children	--	--	--	2.34×10^{-5}[2]
Ingestion of vegetables irrigated with contaminated ground water	--	--	-- --	6.80×10^{-8}[2] to 5.62×10^{-7}

-- Risk analysis does not apply to this exposure scenario.

[1] A hazard index value of greater than 1.0 indicates a potential human health hazard.

[2] Risk attributed to suspected carcinogenic PAH compounds.

[3] Risk attributed to benzene, methylene chloride, and suspected carcinogenic PAH compounds.

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TABLE 9

ESTIMATED GROUND WATER CARCINOGENIC RISK FOR THE FUTURE - NO ACTION SCENARIO
(Assuming Ingestion of Ground Water)

Well No.	Carcinogenic Risk Present	10-year	30-year
1023	2.71×10^{-7}	2.64×10^{-6}	4.57×10^{-5}
1100	3.24×10^{-4}	8.63×10^{-4}	3.15×10^{-3}
1105	1.21×10^{-4}	3.63×10^{-4}	1.18×10^{-3}
1030	2.86×10^{-4}	7.63×10^{-4}	2.03×10^{-3}

18.b

Risk Characterization: Ground Water, Lower Aquifer

There are no complete exposure pathways for the lower aquifer since there are no known domestic wells which are completed in this horizon. A human health risk evaluation was therefore performed for only one scenario which assumes a domestic-use well is installed in this aquifer at some time in the future. Exposure pathways are the same as those for the upper aquifer.

Table 10 presents the carcinogenic risks and hazard indices for the no-action exposure scenario. Carcinogenic risks are slightly higher than those for the upper aquifer (total 4.99×10^{-4}) because contaminant concentrations are estimated to be higher than those calculated in the baseline, upper aquifer evaluation. Once again, the subchronic hazard index for fetotoxic effects related to pentachlorophenol exposure exceeds unity.

Environmental Risks: Ground Water, Upper and Lower Aquifers

Environmental risks posed by contamination in the ground waters of both aquifers are associated with continued degradation of the aquifers and potential discharge of contaminant plumes to surface waters of the Kootenai River and Flower Creek. Risk evaluations are based on continued migration of plumes.

Both aquifers are contaminated with a variety of compounds, some lighter than water and some more dense. The contamination of the aquifers can be represented by plumes defined by years of ground water sampling and analysis. These plumes appear to be migrating very slowly and may have reached a near steady state. However, further plume migration presents further potential environmental risk, as incremental portions of the aquifers are damaged. Continued degradation of the aquifers is considered an environmental risk. It is worth noting that Montana non-degradation policies in ground water are based on this approach.

A more recognizeable risk is posed by continued plume migration until ground waters discharge into downgradient surface waters. No detectable concentrations of contaminants have been measured in either water or sediment samples taken from the Kootenai and Flower Creek, suggesting there have been no environmental impacts to date.

A statistical model was used to evaluate the potential for contaminant discharge to both surface systems, using a plume migration rate based on historical travel distance. Without remedial correction, the northwest-trending ground water plume (Figure 9) is estimated to reach Flower Creek in approximately 30 years. The north-trending plume is estimated to reach the

TABLE 10
NO ACTION PUBLIC HEALTH EVALUATION SUMMARY OF HAZARD INDICES AND CARCINOGENIC RISKS FOR LOWER AQUIFER

	Total Subchronic Hazard Index(1)	Total Subchronic Hazard Index for Fetotoxic Substances	Total Chronic Hazard Index(1)	Total Carcinogenic Risk
Ground water ingestion	0.148	76.7	0.556	3.29×10^{-4}(3)
Ingestion of soil by children	--	--	--	1.67×10^{-4}(2)
Ingestion of vegetables irrigated with contaminated ground water	--	--	--	3.00×10^{-6} to 3.59×10^{-7}(2)
Total	0.148	76.7	0.556	4.99×10^{-4} to 4.96×10^{-4}

-- Risk analysis does not apply to this exposure scenario

(1) A hazard index value of greater than 1.0 indicates a potential human health hazard

(2) Risk attributed to suspected carcinogenic PAH compounds (benzo(a)anthracene, pyrene, chrysene, fluoranthene)

(3) Risk attributed to benzene, methylene chloride, tetrachloroethylene, and suspected carcinogenic PAH compounds

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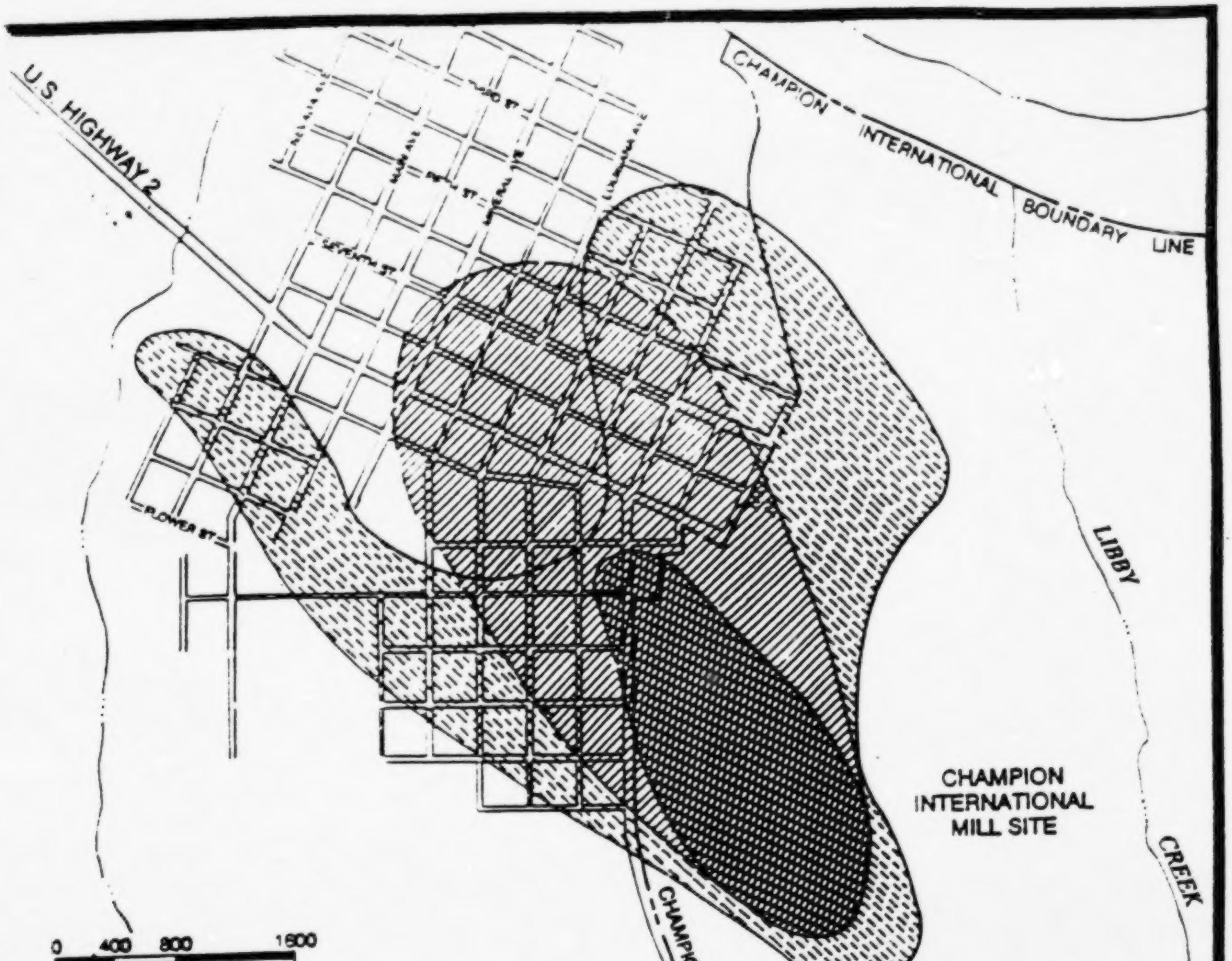
Figure 8


U.S. HIGHWAY 2
THIRD ST
FIFTH ST
SEVENTH ST
FLOWER ST
CHAMPION INTERNATIONAL BOUNDARY LINE
LIBBY CREEK
CHAMPION INTERNATIONAL MILL SITE
CHAMPION INTERNATIONAL BOUNDARY
U.S. HIGHWAY 2
0
400
800
1600
SCALE IN FEET
LEGEND
UPPER AQUIFER CONTAMINANT PLUME
LOWER AQUIFER CONTAMINANT PLUME
LOWER AQUIFER FREE PRODUCT HEAVY OIL POOLS AREA
N
E
S
W

Ground Water Contaminant Plumes

Kootenai River in approximately 25 years. Other more mobile contaminants, such as penta, may reach these water systems in fewer years, if remedial action is not taken and contaminants migrate.

Piezometric data for the shallow aquifer indicate that Flower Creek may not be recharged by ground water flow from the east in the Libby area. Ground water gradients near the creek trend to the north, suggesting there is not recharge to the surface except possibly near the creek confluence with the Kootenai River. Therefore, no significant environmental impact is estimated for Flower Creek under a no-action scenario.

A numerical model was used to estimate a discharge of 22.51 million gallons per day from the upper aquifer into the Kootenai River. The same volume was used for the lower aquifer which has generally lower productivity, thus creating a conservative assumption. Projected contaminant concentrations for the Kootenai River are estimated using maximum and geometric mean concentrations for each aquifer. Compounds evaluated are indicator chemicals. Table 11 shows the resulting Kootenai River concentration estimates. Comparison of these concentrations with available Water Quality Criteria for Protection of Aquatic Life indicates that values are below existing acute and chronic toxicity numbers, but organic concentrations are obviously above the existing non-degradation water quality criteria.

Evaluation of the potential for oil (product) migration into the Kootenai River was also conducted. Further movement of oil pools is considered unlikely because much of the oil is thought to be captured in small traps of lesser permeable materials and sediment barriers. Additionally, continued migration of the oils may have resulted in such depletion of pooled masses that critical quantities for movement may not be present.

However, an estimate of the impact of oil migration based on worst-case assumptions was conducted. Using a 2-year minimum flow for the Kootenai River, it is calculated that product would have to enter the river at a rate of 13 gal/day in order for penta or suspected carcinogenic compounds (as well as dibenzo-p-dioxins and/or furans) to be detectable at 0.5 parts per billion. Although this is an unlikely scenario, the uncertainties in the assumptions used for prediction would indicate that monitoring of plume movement is essential.

VII. Documentation of Significant Changes

Preferred Alternative - The following alternatives were identified in the proposed plan as the remedies EPA and MDHES preferred to be implemented at the Libby site:

- Soils and Source Areas - Alternative 5A2: Excavation of

TABLE 12

ESTIMATED CONTAMINANT CONCENTRATIONS IN THE KOOTENAI RIVER FOLLOWING GROUND WATER RECHARGE FROM THE UPPER AND LOWER AQUIFERS AT LIBBY, MONTANA

Compound	Using Upper Aquifer Maximum (µg/l)	Using Upper Aquifer Geometric Mean (µg/l)	Using Lower Aquifer Maximum (µg/l)	Using Lower Aquifer Geometric Mean (µg/l)	Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic[1] (µg/l)
Benzene	0.035	0.006	0.009	0.007	5,300/--
Benzo(a)anthracene	0.0002	0.0002	0.0002	0.0002	--/--
2-Butanone	0.403	0.024	0.0158	0.013	--/--
Chromium III	0.030	0.015	0.240	0.033	1,700/210
Chrysene	0.009	0.0004	0.001	0.0007	--/--
Copper	0.28	0.092	0.030	0.009	18/12
1,1 Dichloroethane	0.001	0.001	--	--	--/--
Ethylbenzene	0.033	0.004	0.007	0.003	32,000/--
Fluoranthene	0.002	0.0005	0.001	0.0003	3,980/--
Lead	0.061	0.057	0.123	0.022	82/3.2
Methylene Chloride	0.028	0.004	0.542	0.217	--/--
Nickel	0.138	0.042	0.133	0.038	1,400/160
Pentachlorophenol	5.60	0.091	4.03	0.184	20/13
Pyrene	0.001	0.0005	0.001	0.0003	--/--
Tetrachloroethylene	0.003	0.002	--	--	5,280/840
Toluene	0.089	0.003	0.023	0.002	17,500/--
1,1,2-Trichloro-2,2,1-Trifluoroethane	0.028	0.011	--	--	--/--
Xylenes	0.191	0.011	--	--	--/--
Zinc	3.52	1.12	0.193	0.065	120/110
Carcinogenic PAHs	0.012	0.002	0.004	0.001	--/--

PAH - polynuclear aromatic hydrocarbon

[1] - USEPA, 1986, Ambient Water Quality Criteria Maximum Freshwater Concentration for Chronic Effects (pH = 7.8)

20.a

contaminated soils from the butt dip and tank farm areas and placement in the waste pit area. Initial phase of biodegradation treatment. Transfer of soils lifts to the land treatment unit for final treatment and disposition. Capping of land treatment unit.

- Upper Aquifer - Alternative 5B: Extraction of product saturated zone near the waste pit area. Separation of oil phase, treatment of ground water in a fixed bed bioreaction unit, and reinjection of treated water to assist in contaminant reduction in the waste pit area saturated zone. Installation of injection wells in two regions to add nutrients and oxygen to the aquifer system, thereby stimulating biologic activity to metabolize (destroy) contaminants in-situ.

- Lower Aquifer - Alternative 5C: Implementation of a bioremediation pilot test system to evaluate the effectiveness of this technology, in conjunction with oil recovery techniques, in a region with heavy ground water contamination by dissolved and non-aqueous phase constituents. Pilot testing is projected to require two years, although no time limit will be imposed in order not to constrict the completeness of the evaluation. Subsequent to pilot testing EPA will determine the feasibility of implementing a full-scale aquifer remediation system. Should the technologies not prove effective, the selected remedy will consist of monitoring and institutional controls, with remedy review at 5 year intervals.

Description of Significant Changes: EPA proposed that final treatment and disposition of contaminated soils would be in an unlined cell, in accordance with alternative 5A2. This alternative was selected based on a belief that contaminants in the land treatment demonstration unit would not migrate downward through the treatment zone. Field data from the land treatment demonstration unit, received during the public comment period, indicates that some downward migration of pentachlorophenol occurred during treatment. Although the concentrations of penta detected at various depths below the surface treatment zone are well below the cleanup levels prescribed later in this ROD, the presence of this compound demonstrates a potential for migration during remedial action.

EPA has therefore determined that the land treatment and disposal unit constructed for clean up of soils and source areas will require a bottom liner system. The soils and source areas response action is therefore based on alternative 5A1. The liner system will provide a low permeability barrier to leachate migration, and potentially a contaminant sorpant as well. Although alternative 5A1 used a specific barrier system design for engineering and cost analysis, final determination of land treatment unit configuration will be made during remedial design. This change is not a major change, and it does not require EPA to obtain public comment on a proposed plan reflecting this change. (See Section 117(b) of CERCLA).

Another item worth mentioning is the decision to make an interim remedy selection for the lower aquifer response action. Although no mention was made of this issue in the proposed plan, EPA had anticipated selecting Alternative 5C as a final remedy, pending successful pilot testing. However, due to the uncertainties of the technologies which will be used to evaluate remediation of the lower aquifer, the Agency believes that a final remedy determination should not be made at this time. The significance of this decision is that a final remedy will be selected in a subsequent Record of Decision. In all other ways, the alternative will be carried out as proposed.

VIII. Description of Alternatives

A brief but comprehensive description of each of the remedial action alternatives considered during detailed evaluation for each of the three sub-actions will be presented. A more thorough description and discussion of the alternatives is presented in Chapters 6, 7 and 8 of the Feasibility Study Report for Site Remediation, 1988. Codes used in these descriptions (4A, 3B, etc) are consistent with those presented in the FS Report. Caution is given that capital, operation and maintenance (O & M), and present worth costs, as well as timelines for remedial action implementation and completion, are necessarily estimates which may be revised as further remedial design is conducted.

Sub-Action A - Soils/Source Areas

Table 12 lists the remedial alternatives considered for soils and source area remediation, and classifies those alternatives as non-treatment, source control/containment, treatment, or innovative treatment alternatives. Table 13 presents a summary of the capital, O & M and present worth costs for each contaminated soils remedial alternative. Where implementation requirements are the same for more than one alternative, discussion will be presented once and referenced thereafter. Also, the description of applicable or relevant and appropriate requirements is limited to those which are considered major and/or unique to a certain alternative. For instance, all excavation alternatives will have applicable requirements concerning worker safety (OSHA) and RCRA closure. However, these are not discussed in detail for each excavation alternative. A more comprehensive list of ARARs is available in Appendix K of the Feasibility Study Report, and discussion of particular ARARs for each alternative is contained in Chapters 6 and 8 of that

TABLE 12

REMEDIAL ALTERNATIVES FOR SOIL: OPERABLE UNIT A

Nontreatment	1A	No Action
	2A	Institutional Controls
Source Control/Containment	3A	Capping of Contaminated Soils
	4A	Excavation and On-Site Landfill
Treatments	5A	Excavation of Soils and On-Site Land Treatment
	6A	Excavation of Soils, On-Site Incineration and Land Disposal
Innovative Treatment	7A	Excavation of Soils, Soil/Slurry Bioreactor Treatment and On-Site Land Disposal

Sheet 1 of 1

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TABLE 13

- COST SUMMARY FOR REMEDIATION OF CONTAMINATED SOILS

Alternative	Capital Cost ($)		Annual Operation and Maintenance Cost ($)		Present Value Cost ($)	Unit[4] Cost ($/yd^3)
	Yr 1	Yr 6[1]	Yr 2-5[2]	Yr 2-30[3]		
1A - NO ACTION	---		---	---		
2A - INSTITUTIONAL CONTROLS	3,400		---	2,500	39,300	1
3A - CAPPING IN PLACE	1,814,000		---	36,000	2,252,500	75
5A - LAND TREATMENT						
5A-1 With liner	1,019,200	1,335,800	189,000	23,000	2,862,600	95
5A-2 Without liner	106,800	783,500	248,000	23,000	1,780,800	60
6A - INCINERATION	8,170,000		---	24,000	7,947,300	265
7A - SOIL/SLURRY BIOREACTOR	4,828,900		---	23,000	4,933,500	164

22.6

[1] Closure
[2] LTU operations
[3] Monitoring operations
[4] 30,000 yd^3 basis

report.

Alternative 1A - No Action: This alternative assumes no action will be taken to contain or treat contaminated soils at the site. Because contaminated soils contribute to ground water contamination a no-action alternative will present significant long-term health risks. Short and long-term health risks are presented through exposure scenarios involving land development and/or industrial activity and/or construction activity. Leaching of contaminants into the underlying ground water systems will continue to present an environmental threat. Costs required to implement and maintain this alternative are zero. No ARARs are met by this alternative.

Alternative 2A - Institutional Controls: Institutional controls applicable to soils contamination consist of deed restrictions on land use as well as maintenance of existing site access restrictions. Land deed restrictions would limit the potential future uses in the event of a sale. Institutional controls assume no action will be taken to contain or treat contaminated soils at the site. Institutional controls are not fully protective of human health if implemented alone due to the continued ground water pathway exposure and uncertainty associated with deed restrictions maintenance. Short and long-term health risks are presented through exposure scenarios involving on-site industrial activity and/or construction activity, unless limitations could be placed on use by present or future site owners. Leaching of contaminants into the underlying ground water systems will continue to present an environmental threat if this alternative is implemented alone. No ARARs are met by this alternative.

Costs required to implement this alternative are approximately $3,400 in capital expenditure; $2,500 per year in annual O & M; and $39,300 in present worth cost. Although evaluated as a stand-alone remedial alternative, institutional controls are also an integral part of many of the remaining alternatives considered.

Alternative 3A - In-Place Capping of Contaminated Soils: Protective caps, considered an on-site waste containment alternative, could be constructed over areas of highly contaminated soils in the waste pit area, tank farm area and butt dip tank area. Areas covered by the caps would be approximately 135,000 ft^2 at the waste pit area, 77,300 ft^2 at the tank farm area and 12,300 ft^2 at the butt dip tank area. Areas to be capped would be cleared of any existing structures and/or vegetation and graded to meet slope requirements. Monitoring wells would be installed both upgradient and downgradient of the capped areas. Caps would be designed to: (1) provide long-term minimization of migration of liquids through the cap, (2) function with minimum maintenance, (3) promote drainage and minimize cover abrasion or erosion, (4) accomodate settling and subsidence, and (5) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. Cap construction could be completed in less than one year, and monitoring would continue for 30 years.

Caps would provide short-term protection of human health, but long-term (>30 years) protection is less certain, due to the potential for failure or destruction of the physical integrity and possible halting of monitoring. Environmental impacts are lessened (relative to no-action) because of the reduction in fluid migration through the source materials and resultant reduction in contaminant leaching into the ground water.

Capital cost to implement this alternative is estimated to be $1,814,000. Annual O & M costs are $36,000, while the present worth cost is $2,252,500.

Relevant and appropriate requirements for this alternative include certain portions of the RCRA Closure and Post Closure care for a surface impoundment. Post closure care restricts the use of the property as necessary to prevent damage to the cover, a form of institutional control. Land disposal restrictions would not be ARAR for this alternative because waste materials will not be removed from existing locations and placement would not occur. ARARs for this alternative would generally be met. CERCLA's preference for remedies which use treatment to reduce contaminant mobility, toxicity or volume would not be met.

Alternative 5A(2) - Excavation and Land Treatment, Without Liner:

Contaminated soils from all waste areas would be excavated and treated in the waste pit area using enhanced biodegradation techniques to reduce contaminant concentrations. The volume of soils that require excavation and treatment is estimated to be 30,000 yd^3. Excavated soils from all locations would be treated in the waste pit area until contaminant concentrations have been reduced 50% to 80%. The butt dip and tank farm areas would be backfilled after excavation, and relevant and appropriate RCRA closure requirements would be met for these areas. All soils targeted for treatment would be screened to remove rocks and debris. After all contaminated soils are transferred, the waste pit would be closed in accordance with relevant and appropriate RCRA requirements. Prior to or concurrent with this activity the second step treatment cell or unit would be constructed. This land treatment unit (LTU) would consist of an unlined cell approximately 3.5 acres in size surrounded by a berm designed to divert run-on away from the unit and to contain runoff. Contaminated soils from the waste pit, applied to the unit in stages, would be tilled to a depth of 12 inches, corresponding to the zone of incorporation. The treatment zone would extend to approximately 5 feet below the initial ground surface. Since ground water is at a depth of 15 feet, the base of the treatment zone would be more than 1 meter above ground water as required by RCRA land treatment regulation (40 CFR 264.271(c)(2)).

Monitoring of the unsaturated zone within the land treatment unit would be conducted to determine whether contaminants are migrating through the treatment zone. Lysimeters would be installed at the base of the treatment zone to collect soil pore liquid and soil cores would be collected within the treatment zone. Monitoring wells would be installed upgradient and downgradient of the LTU to monitor ground water. The LTU would be operated in accordance with RCRA regulations.

The LTU would be closed by capping when treatment is complete (see later section on cleanup criteria). Although treatment would be conducted to achieve acceptable contaminant concentrations, determined using health based risk calculations, capping is required because some level of contamination will remain in the LTU. The cap system would consist of (from the base upward) (1) a 24-inch thick compacted clay layer, (2) a geotextile filter fabric, and (3) a 3-inch thick gravel layer with an asphalt tack coat. Closure and post closure care would be done in accordance with RCRA requirements.

Biodegradation of organic wood treating wastes in a soils matrix has been proven effective at other hazardous waste locations throughout the country. Successful land treatment was demonstrated at the Brainerd Superfund wood preserving site in Minnesota[8] and a successful demonstration of PAH degradation was conducted for the Paradise Land Treatment facility in northwestern Montana[9]. Bench scale laboratory studies conducted on wastes from the Libby site indicate land treatment is a viable approach for reducing especially PAH waste components (See Appendix N, Libby FS Report, 1988). Results of field demonstrations performed on Libby wastes using innovative (enhanced biomass) land treatment techniques during the summer of 1988 suggest appreciable and relatively rapid degradation of Penta and PAH components (See appendix O, Libby FS Report, 1988).

It is believed that land treatment biodegradation processes would not reduce the low levels of chlorinated dibenzo-p-dioxins and dibenzofurans found in some areas of soil contamination. The low permeability cap installed as part of the LTU closure would prevent human or environmental exposure to these compounds, although, as discussed in alternative 3A, caps are not considered protective in the long term because of the potential for failure or destruction.

Long-term monitoring and maintenance requirements would need to be established for this remedy. Short term exposure risks may be created; for instance, handling and processing of contaminated materials increases the potential for exposure. Precautions would need to be taken to prevent worker exposure to contamination during excavation and during land treatment as well, since volatilization of some compounds will occur. Proper design, engineering controls and worker protection can effectively reduce potential risks.

This alternative would be expected to take 4 to 6 years to complete treatment and achieve LTU closure. Capital cost to implement this alternative is estimated to be $890,300. Annual O & M costs are $248,600 for each year of active land treatment (est. 5 years) and $23,000 per year thereafter. Present worth cost is $1,780,800.

The major applicable or relevant and appropriate requirements (ARARs) for this alternative are as follows. A land treatment unit must be designed and operated to meet the RCRA land treatment technology requirements, 40 CFR 264 Subpart M. Relevant and appropriate or applicable requirements of RCRA 40 CFR 264 Subparts G, K, L, and N must be followed to close the butt dip, tank farm and waste pit areas, and to cap and close the LTU. Because land treatment is considered land disposal, land disposal restrictions are ARAR for the LTU, assuming that BDAT concentrations cannot be met prior to placement by August 8, 1990. In addition, based on field tests, one compound may remain at concentrations above the BDAT levels, even after active treatment is halted. Should placement of wastes in the LTU at concentrations above BDAT levels appear to be the most likely situation, a demonstration of no-migration from the LTU will provide ARAR compliance. BDAT numbers which are achievable are relevant and appropriate end of treatment numbers for this cleanup.

Alternative 5A(1) - Excavation and Land Treatment, with Liner:

This alternative is a variation on 5A(2) which requires final treatment and disposal of materials in a lined LTU. The following discussion will therefore only cover those portions of the alternative which differ from that presented above.

The LTU design would consist of a lined area approximately 3.5 acres in size. The lining system would be used to stop migration of leachate from the LTU. One possible design of a liner system, evaluated in the FS report, would consist, from the base upward, of (1) an 18-inch thick compacted clay liner, (2) a 60-mil. thick high-density polyethylene (HDPE) geomembrane, (3) a 12-inch thick drainage sand layer, (4) a geotextile filter fabric, and (5) an 18-inch thick clean fill layer protecting the liner system from damage during operation of the LTU. This composite liner would provide a barrier to the downward migration of liquids from the LTU. The sand layer would drain any liquids leaching through the soils overlying the liner. Liquids would be collected in a leachate collection sump and removed, stored in above-ground storage tanks and recycled in the LTU by irrigation. Leachate collected would be sampled periodically for contamination. Monitoring wells would be installed upgradient and downgradient of the LTU to monitor ground water.

The LTU would be closed by capping when treatment is complete (see later section on cleanup criteria). The cap system for this alternative would be different from that of the unlined LTU system because a lower permeability is needed to reduce the potential for water to collect in the bottom of the cell. The cap system would consist, from the base upward, of (1) a 24-inch thick compacted clay layer, (2) a 60-mil. thick HDPE geomembrane, (3) a geotextile fabric protecting the geomembrane, (4) a 12-inch thick drainage sand layer, (5) a geotextile filter fabric, and (6) a 3-inch thick gravel layer with an asphalt tack coat. Difficulties inherent in this alternative are similar to alternative 5(A)2.

Capital cost to implement this alternative is estimated to be $2,335,000. Annual O & M costs are $189,000 for each year of active land treatment (est. 5 years) and $23,000 per year thereafter. Present worth cost is $2,862,600.

Applicable or relevant and appropriate requirements for alternative 5(A)2 will be the same as for land treatment without a liner. ARARs for this alternative would be met.

Alternative 6A - Excavation of Contaminated Soils, On-Site Incineration and Landfilling:

Contaminated soils from the tank farm and butt dip areas would be excavated and placed into a bermed containment zone in the area of the waste pit until the mobile incinerator is operational. Excavation areas would be backfilled and closed. A landfill would be constructed south of the waste pit. Contaminated soils would be screened to remove debris and rocks which, after washing to remove the majority of contamination, would be placed in the landfill. Contaminated soils would be fed into a fluidized bed incinerator at a rate of approximately 11,000 lbs/hr. Soils would be incinerated to approximately 85% of their original mass after organic components have been oxidized. Treated soils would be placed in the landfill, which would be designed for solid residues from a hazardous waste incinerator.

Treatment by fluidized bed incineration is a proven technology for sludges and liquid wastes and has been demonstrated for treatments of organic compounds in soils. It is believed that acceptable results can be expected for the contaminated soils found at Libby, however a test burn would be required to demonstrate the required dioxin destruction and removal efficiency of 99.9999%. This alternative would be expected to take two years to complete, followed by post-closure monitoring of the land disposal cell for up to 30 years.

Capital cost to implement this alternative is estimated to be $8,170,000. Annual O & M costs are $24,000 per year for the next 30 years. The present worth cost is $7,947,300.

The major applicable or relevant and appropriate requirements (ARARs) for this alternative are as follows. Incineration of soils will require meeting the requirements of RCRA technology standards for a hazardous waste incineration, 40 CFR 264 Subpart O. Montana has also developed emission standards for the operation of an incinerator. The operation of the incinerator would have to consider applicable new stationary source requirements under the Clear Air Act. Montana Ambient Air Quality Standards cannot be exceeded. The excavation areas will require closure as in alternative 5A(2), and the landfill used for disposal of wastes and residues must be designed and operated according to RCRA requirements and closed under Subtitle C. Land disposal requirements would be met for this alternative because incineration is the best demonstrated available technology (BDAT) upon which the land disposal restricted waste concentrations were developed. Therefore, BDAT treatment levels would be met prior to placement in a land disposal unit. Incineration should reduce the contaminants to concentrations less than those which would be subject to land disposal restrictions. There is some uncertainty as to whether air requirements for incinerators could be met. RCRA operational and closure ARARs would be met.

Alternative 7A - Excavation of Soils and Treatment using a Soil/Slurry Bioreactor:

Contaminated soils from the tank farm and butt dip areas would be placed into the bermed area of the waste pit. Front-end loaders would feed soils into a hopper and conveyor to a primary screening step, which would segregate debris and rock from soils. Rock and debris would be placed in a storage pile. After further soils screening and "shredding" to reduce all materials to a fine size, soils would enter the biotreatment units.

The soil/slurry bioreactor is considered an innovative variation of soil biodegradation processes described earlier in land treatment. Soils would be fed into a mixer and agitated with a concentrated solution of microbes and surfactants. The wet slurry passes through a spray washer where large particles are mechanically washed and ejected, and fine slurry proceeds to a series of liquid/solid contact bioreactors. Mixers or bottom air spargers are used to enhance aerobic biodegradation. Once treated, the slurry is dewatered, with solids removed to land disposal or replacement in the excavation areas. Some treated soils may need subsequent land farming to achieve requisite cleanup levels. The rocks and debris separated from the soil during screening may be fed separately into the slurry bioreactor for treatment, or used in conjunction with ground water clean up.

The soil/slurry bioreactor should achieve necessary cleanup levels, but it is recognized that additional land farming may be required for some batches. Whether additional land treatment is conducted or not, a land disposal facility would be needed for final disposition of the treated soils and possibly rock and debris. The land disposal facility (or, if necessary, LTU) would have similar design requirements as those discussed for alternative 5(A)2.

Evaluation conducted for the Feasibility Study Report suggested that the soil/slurry bioreactor could achieve desired cleanup levels within one year from implementation, but that site demonstration may be required to verify this level of operational effectiveness. Additionally, long-term monitoring and maintenance requirements are established by the need for a disposal area and/or land treatment unit. Short-term exposure risks may be created using this alternative. For instance, as in all excavation alternatives, handling and processing of contaminated materials increases the potential for exposure, as does shredding of soils for the bioreactor and volatilization of organic compounds. Proper design, engineering controls and worker protection can effectively reduce the potential risks. Long-term protection of human health and the environment is satisfactorily achieved in a manner similar to alternatives 5(A)1 and 5(A)2, discussed above.

Capital cost to implement this alternative is estimated to be $4,828,900. Annual O & M costs are $23,000 per year thereafter for 30 years. The present worth cost is $4,933,500.

The major ARARs for this alternative are similar to those discussed for alternative 5A(2) above. Land disposal restrictions are ARAR for this alternative assuming that treatment to less than BDAT concentrations and placement cannot be completed by August 8, 1990. ARARs for this alternative would be met.

Sub-Action B - Ground Water Treatment, Upper Aquifer

Table 14 lists the remedial alternatives considered for ground water treatment of the upper aquifer, and classifies those alternatives as non-treatment, control/treatment and innovative treatment alternatives. This operable unit is focused on treatment of contamination within the upper water-bearing units (approximately 15 to 70+ feet below ground water surface), referred to in this document as the upper aquifer. Table 15 presents a summary of the capital, O & M and present worth costs for each upper aquifer ground water treatment alternative. In the following descriptions, where implementation requirements are

TABLE 14

REMEDIAL ALTERNATIVES FOR GROUND WATER: OPERABLE UNIT B

NonTreatment Alternatives	1B	No Action
	2B	Monitoring
	3B	Institutional Controls
Control/Treatment	4B	Pumping and Treatment Fixed Bed Bioreactor Rotating Biological Contactor Granular Activated Carbon
Innovative Treatment	5B	In-Situ Bioremediation of Dissolved and Sorbed Organics

29.a

TABLE 15

COST SUMMARY FOR REMEDIATION OF CONTAMINATED GROUND WATER

Alternative	Capital Cost ($)	Annual Operation and Maintenance Cost ($)		Present Value Cost ($)	Unit[3] Cost ($/gal/day)
	Yr 1	Yr 2-12[1]	Yr 2-30[2]		
1B - NO ACTION	---	---	---	---	---
2B - MONITORING	84,000	---	84,000	1,295,300	---
3B - INSTITUTIONAL CONTROLS	42,000	---	42,000	737,900	---
4B - PUMP AND TREAT BY:			(Yr 1-30)		
• 4B-1 - RBC	2,269,500	769,000	57,000	8,827,000	12
• 4B-2 - GAC	3,254,300	1,014,000	57,000	11,308,000	16
5B - IN-SITU BIODEGRADATION	874,400	458,200 (Yr 2) 209,200 (Yr 2-6)	57,000	2,914,500	4

29.6

[1] Operational period
[2] Monitoring
[3] 720,000 gallons of water treated per day

the same for more than one alternative, discussion will be presented once and referenced thereafter. Also, the description of applicable or relevant and appropriate requirements is limited to those which are considered major and/or unique to a certain alternative. For instance, all alternatives which include discharge or potential discharge of treated water to a surface water body will have to meet the applicable requirements established by State of Montana ARM 16.20.631 *et seq*. However, these will not be discussed in detail for each alternative. A more comprehensive list of ARARs is available in Appendix K of the FS Report, and discussion of particular ARARs for each alternative is contained in Chapters 6 and 8 of that report.

Alternative 1B - No Action: This alternative assumes no action will be taken to treat or contain contaminated ground water at the Libby site. The upper aquifer presents the principal risk concern to human health stemming from contamination at this site. The no-action alternative for contamination in the upper aquifer would not provide long-term protection of human health. Additionally, there are long-term impacts upon the environment through migration of contaminant plumes and potential discharge of contamination into Flower Creek and the Kootenai River. Although no activity would be taken in conjunction with this alternative, there are applicable or relevent and appropriate requirements. Continued migration of the contaminant plumes would be a violation of the Montana Non-Degradation of Water Quality Statutes, including ARM 16.20.1011. Continuing contamination of the ground water would violate Montana regulations governing Public Water Supplies. In particular, ARMs 16.20.203, 204, 205 and 207 establish maximum contaminant levels for various organic and inorganic compounds in public water supplies. Although the upper aquifer does not replenish a public water supply these regulations are considered relevant and appropriate to the problem. Discharge of contaminants into the Kootenai River or other surface water bodies may violate relevant and appropriate Montana Surface Water Quality requirements. There are no costs associated with implementation of this alternative.

Alternative 2B - Monitoring: Monitoring would be conducted to: (1) Identify and track contaminant concentration gradients and trends at locations of potential interest which would enable the prediction of future contaminant levels on and off-site; (2) provide ground water contaminant data showing any effects of other remediation (i.e., soils cleanup) being conducted across the site, and (3) provide a data base to determine changes in potential public health and/or environmental risks associated with ground water exposure pathways.

The monitoring network conceived for this alternative would follow closely a program established in the spring of 1987, during site investigation activities. Selected off-site wells would be monitored on an annual basis, and sampling of other selected off-site wells would be on a semi-annual basis. The rationale for the wells to be sampled and sampling frequency is based on well accessibility, targeting of well owners not participating in the buy-water plan, and the distribution of contaminants in the ground water as developed by a statistical model presented in Appendix E of the FS Report. Chemical parameters to be monitored would include PAH compounds, Penta, VOCs, dibenzo-p-dioxins and dibenzofurans, and selected metals. All chemical parameters would not necessarily be monitored at each well. For purposes of cost comparison, the monitoring program was projected to last 30 years, although continued ground water contamination could require a much longer monitoring effort.

Short and long-term human health and environmental effects are the same as for the no-action alternative. Ground water monitoring does not of itself affect the short or long-term effectiveness of remediation at the site, but it would provide data to evaluate the effectiveness of other remediation actions.

Capital costs associated with this alternative are zero. Annual O & M costs are estimated to be $84,000 per year for thirty years. The present worth cost of this alternative is $1,295,300. ARARs for the monitoring alternative are the same as for 1B. ARARs for this alternative would not be met.

Portions or all of this monitoring alternative are included as integral parts of the following alternatives.

Alternative 3B - Institutional Controls: During the summer of 1986, the city of Libby passed City Ordinance #1353, prohibiting the installation of new ground water wells for the purpose of human consumption and lawn and garden irrigation. The institutional controls contained in this alternative consist of a continuation of that ordinance and, if needed in the future, passage of a similar control by Lincoln County for some areas which could be impacted by contaminant plume migration. This institutional control prevents use of the contaminated aquifer by future well owners. Evaluation of this alternative also considers continued implementation, and possibly further expansion, of the buy-water program instituted by Champion International Corporation in 1985 to provide alternate water supplies to City residents. This institutional control encourages present well owners to discontinue use of the contaminated aquifer.

Regulatory prohibitions precluding water use can be immediately effective in limiting human exposure to contamination. The ordinance against well drilling is an example of institutional controls preventing further opportunities for human exposure. Expansion of the buy-water plan, should contamination migrate, will provide individuals the opportunity to use clean water for all needs. However, the buy-water plan is voluntary; individuals with contaminated ground water wells are not required to take part in the program. Also, the City Ordinance only prohibits the installation of new wells. It does not condemn existing water wells within the contaminant plumes or prevent owners from using them. A few well owners have chosen not to participate and continue to use well water for irrigation and, in at least one instance, for consumption. In addition, it is difficult to guarantee the long term continuation and enforcement of the institutional controls. Therefore, institutional controls can be partially effective in protecting human health in the short-term, but controls such as the City Ordinance and buy-water plan are not considered permanent or reliable remedies.

Capital cost to implement this alternative is estimated to be zero. Annual O & M costs are approximately $42,000. Present worth cost, based on a thirty year lifetime, is estimated to be $737,900. The ARARs associated with this alternative are the same as for alternative 1B. ARARs for this alternative would not be met.

Although evaluated as a stand-alone remedial alternative, institutional controls are also an integral part of many of the remaining alternatives considered.

Alternative 4(B)1 - Pump and Treat by Rotating Biological Contactor (RBC): A ground water pump and treat system would be designed to intercept the upper aquifer contaminant plume at a location on site, immediately downgradient of the contaminant source areas. Another extraction system would be installed closer to the edge of contaminant plumes to halt migration, either at the facility boundary or even off-site in residential neighborhoods. Ground water extraction wells would be installed to intercept zones of highest contaminant concentration. Wells would be completed to approximately 70 feet, the lower limit of the upper aquifer, and screened at different intervals, determined by drilling logs. Captured ground water would be routed via underground piping to an on-site treatment plant. Treated effluents would be either (1) reinjected into the ground water in the vicinity of the waste pit area via a rock percolating bed (See alternative 5B) or injection wells, or (2) discharged to the plant's log pond and ultimately to the Kootenai River via the existing MPDES discharge point.

Treatment of ground water in this alternative would be by rotating biological contactor (RBC). An RBC system consists of a series of disks covered with a film of active biomass that is partially submerged in the wastewater. Disk rotation alternately exposes the attached biomass to the substrate-rich wastewater and to the atmosphere. Substrate (including the hazardous constituents) is oxidized and converted to new biomass, soluble metabolic by-products, and gaseous end products. Controlling factors of the RBC system are numerous, including substrate concentration, disk rotational speed, hydraulic load, liquid retention time, and temperature, and pilot testing would be required to demonstrate the effectiveness for the Libby site and refine design considerations.

Prior to treatment, captured ground water would be required to pass through an oil/water separator to remove any free-phase product. Separated oil would be stored on site and ultimately disposed or treated by recycle & reuse or incineration. (Oil treatment options are considered in Sub-Action C). If the water phase coming out of the separator contains residual free phase oil, the stream would be pumped through oil-absorbing media to remove suspended oil particles prior to biotreatment.

Disposal of treated ground water would consist of either discharge to a surface water body, or discharge to a rock percolation bed or injection well, to assist in further source materials remediation. Discharge to a surface water body (fire pond and then Kootenai River) is highly dependent upon the level of treatment which the RBC can achieve. Surface water discharge quality would be governed by the appropriate effluent discharge requirements, including State of Montana nondegradation regulations.

Another method of discharging treated water is via a rock percolation bed. This system would be used as a final polishing step for the treated water. The system would be designed as follows. During soils remediation large volumes of rocks will be excavated from waste areas and separated from soils. These rocks are expected to also have contaminants adsorbed onto surface areas. A large trench (220 ft by 60 ft by 15 ft deep) would be excavated on the south (upgradient) side of the waste pit, the area of most soils contamination and largest source contributor to the ground water. Rocks would be placed in the pit by size, largest at the bottom. A cap of soils would be placed over a piping system near the top to prevent freezing.

Treated water from the RBC would be trickled over the rocks by the network of piping. Pea gravel near the top will help to assure even distribution as the water trickles down through the bed. It is expected that microbial activity and nutrients within the treated effluent from the RBC would be sufficient to enhance bacterial growth on the surface of the rocks. Bacterial growth will help to degrade contaminants adsorbed onto the rocks and also polish the effluent trickling down from the RBC. Because the water will have a high biomass from the trickling bed it should help to enhance natural degradation of the contaminant components in the waste pit.

The pump and treat ground water alternative described above would be very effective in controlling contaminant migration. It probably would not be very effective in reducing contaminant concentrations in the upper aquifer in the short-term because of the probable high content of contaminants adsorbed onto and within aquifer matrices, which will continue to act as a source for dissolved aqueous contamination. This alternative should effectively reduce contaminant concentrations to below desired cleanup levels in the upper aquifer in the long-term, considered to be 10 to 20 years or longer.

Capital cost to implement this alternative is estimated to be $2,269,500. Annual O & M costs for the next 10 years are expected to be $769,000, and $57,000 per year for the next 18 years thereafter. The present worth cost of this alternative is estimated to be $8,827,000. Note: These costs are based on implementation of the alternative on-site; installation of an additional extraction system off-site, to be pumped to the on-site treatment system, would require a signficant increase in capital expenditure.

The pump and treat alternative would have to meet appropriate effluent discharge requirements, including Clean Water Act requirements of the Montana Pollution Discharge Elimination System (MPDES) process, and Montana Nondegradation Standards. Should treated water be disposed via recharge of the aquifer (rock percolation bed), the Nondegradation standards of the Montana Ground Water Pollution Control System may apply, unless injection would be into a ground water of worse quality than the injected effluent, as expected. Underground Injection Control requirements contained in 40 CFR Part 144 are relevant and appropriate for the rock percolation bed recharge system.

A monitoring network and institutional controls similar to those described in alternatives 2B and 3B are integral parts of this alternative.

Alternative 4(B)2 - Pump and Treat by Granular Activated Carbon:

A ground water pump and treat system would be designed to intercept the upper aquifer contaminant plume at a location on site, immediately downgradient of the contaminant source areas. Many of the major activities required in implementation of this alternative are the same as for alternative 4(B)1, described earlier. The following portions will only discuss those aspects of the alternative which differ from 4(B)1.

Treatment of ground water in this alternative would be by Granular Activated Carbon (GAC) adsorption. Activated carbon adsorption is a well-established technology and is often the most effective process for removing high molecular weight compounds.

The activated carbon removes organics by adsorbing them on a microporous surface. Pore size determines the adsorption capacity and affects the adsorption. PAH compounds and phenolics are strongly adsorbable and easily removed by GAC adsorption. Many studies have demonstrated the high granular adsorption capacities for PAHs and Penta, and effectiveness of GAC for removal of contaminants from ground water at a wood preservation facility has also been demonstrated in a laboratory setting[10].

Carbon adsorption capacity is limited and it must be regenerated thermally because neither steam nor solvent will restore the virgin capacity. Thermal regeneration is inconvenient and expensive, and would have to be performed off-site at an EPA permitted facility. Changeout of GAC columns is estimated to be required every 30 days. Construction and operation time frame for this treatment alternative is the same as for 4(B)1, one to two years for construction and startup. Finally, it is anticipated that effluent from this system would be discharged to the fire pond and ultimately the Kootenai River through the MPDES permit.

Short and long-term effectiveness of this alternative is considered to be the same as for alternative 4(B)1. Capital cost to implement the alternative is estimated to be $3,254,300. Annual O & M costs are expected to be $1,014,000 for the next 10 years, and $57,000 per year for the next 18 years thereafter. The present worth cost of this alternative is estimated to be $11,308,000. As with alternative 4(B)1, these costs are based on installation of an on-site extraction system only. Off-site extraction wells and piping would require significantly more capital investment.

The pump and GAC adsorption treatment alternative would have to meet the appropriate effluent discharge requirements for surface water as in alternative 4(B)1. Additionally, RCRA hazardous waste generation and transportation requirements will be ARAR for spent carbon shipped off-site to a regeneration facility. The CERCLA off-site disposal policy, now codified in Section 121(d) of CERCLA, must be complied with for off-site disposal.

A monitoring network and institutional controls similar to those described in alternatives 2B and 3B are integral parts of this alternative.

Alternative 5B - In-Situ Bioremediation: In-situ biorestoration of the upper aquifer would be based on fairly recent remediation technology. The application considered for the Libby site is innovative in both concept and approach. The technology upon which this alternative is based involves the injection of biologically important chemicals into the contaminated zone of the aquifer. Injected chemicals, including hydrogen peroxide and nutrients or fertilizers, stimulate subsurface microbial activity. Because organic contaminants are abundant in the zone, microbial activity leads to biological removal of the contaminants.

In-situ bioremediation has been applied on a pilot scale at the Libby site. (See Appendix J of FS Report for detailed description and analysis). Results of this study indicate that the approach used can produce an oxic zone in a portion of the aquifer. Ground water samples collected from a well located within the oxic zone have contained 100 part per trillion of total organic contamination after treatment. Prior to migration of the oxic zone to this well, organic contamination concentrations were in the part per million range.

Full-scale application of in-situ bioremediation would involve four major activities: 1) installation of source area extraction wells and a treatment system to treat extracted fluids, (2) installation of an injection well system upgradient of the major waste pit area in the upper aquifer contamination, (3) upgrade the existing pilot injection system with one additional injection well to continue injection through this system, and (4) installation of additional monitoring wells in the region downgradient from the injection wells. (These activities would require further refinement during remedial design.)

Extraction wells would be installed just downgradient of the waste pit area. These would be used to recover high concentrations of contaminants and any free-product accumulations in the area of highest ground water contamination. Water extracted would undergo similar phase separation and treatment as that described in alternative 4(B)1 except that a fixed bed bioreaction unit would be utilized. Treated water would be reinjected into a rock percolation bed.

Injection wells would be placed just upgradient from the waste pit area. These wells will be placed in positions to maximize the probability that injection of hydrogen peroxide and nutrients will profuse the saturated zones of the waste pit area, the source of the highest contaminant concentrations in the ground water. In combination with the extraction wells and treatment system described above, ground water flowing below the waste pit in the saturated zone would be treated within a closed-loop system involving active removal by extraction wells, physical treatment in a bioreactor, and in-situ biodegradation stimulation. Isolation of this waste system would help to reduce contaminant loading in downgradient regions.

The existing pilot injection system will be upgraded through the installation of one or more injection wells in the vicinity of the tank farm area. This would place injection wells in a position to inject hydrogen peroxide directly into the second major area of upper aquifer contamination.

Monitoring will be conducted in the regions immediately downgradient from injection wells to gauge the effectiveness of in-situ treatment and refine maximum operational effectiveness assumptions. Additional monitoring wells will be installed. A monitoring network and institutional controls similar to that described in alternatives 2B and 3B are integral parts of this alternative.

The operational period for this alternative is estimated to be 3 to 5 years, but there is a considerable amount of uncertainty inherent in this projection (See appendix M of FS Report). Should the biodegradation program achieve aquifer cleanup in the projected time frame, the short-term effectiveness of this approach would be considerably greater than that of any other active ground water treatment alternative. The long-term effectiveness of in-situ biorestoration is considered much greater than any other alternative described, because bioremediation would destroy organic components in both the aqueous and non-aqueous phases simultaneously.

Capital cost to implement this alternative is estimated to be $874,400. Annual O & M costs are as follows: (1) $458,200 during year 2 of remedial action, (2) $209,200 per year for the next 5 years, and (3) $57,000 per year thereafter. The present worth cost is estimated to be $2,914,500.

The in-situ bioremediation alternative would have to meet similar ARARs as those presented for alternative 4(B)1, except that no surface water discharge will occur. Recharge of treated ground water would have to meet Montana's nondegradation policy requirements.

Sub-Action C - Ground Water Treatment, Lower Aquifer

Table 16 lists the remedial alternatives considered for remediation of the lower aquifer and classifies those alternatives into nontreatment and recovery & treatment catagories. Table 17 presents a summary of the capital, O & M and present worth costs for each lower aquifer remedial alternative. Where implementation requirements are the same for more than one alternative in the following presentation, those requirements will be discussed once and referenced thereafter. Also, the description of applicable or relevant and appropriate requirements is limited to those which are considered major and/or unique to a certain alternative. A more comprehensive list of ARARs is available in Appendix K of the Feasibility Study Report, and discussion of particular ARARs for each alternative is presented in chapters 6 and 8 of that report.

TABLE 16

REMEDIAL ALTERNATIVES FOR OIL: OPERABLE UNIT C

Nontreatment	1C	No Action
	2C	Monitoring
	3C	Institutional Controls
Recovery Treatment	4C	Oil Recovery and Treatment
		Recovery Primary Recovery Tertiary Recovery
		Treatment On-Site Incineration Recondition and Recycle Oil Off-Site Incineration

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TABLE 17

COST SUMMARY FOR RECOVERY AND TREATMENT OF OIL

Alternative	Capital Cost ($)		Annual Operation and Maintenance Cost ($)			Present Value Cost ($)	Unit Cost ($/gal)
	(Yr 1)	(Yr 6)[1]	(Yr 2)[2]	(Yr 3-5)[3]	(Yr 6-30)[4]		
1C - NO ACTION	---		---	---	---	---	---
2C - LOWER AQUIFER MONITORING	66,000		32,000	32,000	32,000	524,300	---
3C - INSTITUTIONAL CONTROLS	---				48,000 (Yr 1-30)	737,900	---
4C - OIL RECOVERY & TREATMENT							
4C-1 On-Site Incineration	2,948,700	2,622,400	505,200	1,300,100	32,200	9,163,600	31
4C-2 Recycle/Reuse	2,948,700		505,200	1,300,100	32,000	7,206,700	25
Extended Pump & Treatment (add on to 4C-1 or 4C-2)		3,187,000	---	---	1,327,300	16,164,000	---

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[1] Incineration (4C-1) and extended pump and treat system construction
[2] Primary oil recovery for 4C
[3] Tertiary oil recovery for 4C
[4] Monitoring and extended pump and treat operation

Sheet 1 of 1

This sub-action focuses on remediation of the lower aquifer, located from approximately 100 feet below ground surface to 150 feet below ground surface. Dissolved contaminant concentrations in the lower aquifer are comparable to those in the upper aquifer. However, the lower aquifer is thought to contain significant quantities of oil product, or non-aqueous phase liquid (NAPL), and remediation of the lower aquifer has therefore focused on recovery of the product material which acts as an ongoing source of ground water contamination. The FS Report describes the problems associated with recovery of oil from the lower aquifer in detail in Appendix F. Many of the calculations used to evaluate the following alternatives are derived in that appendix.

Alternative 1C - No Action: This alternative assumes no action will be taken to remediate the lower aquifer. Because contaminants present in the lower aquifer would remain and possibly migrate further downgradient, the no-action alternative will continue to present potential risks to human health and the environment. Short-term impacts can be minimized assuming continued maintenance of the City Ordinance against drilling new wells, since it is believed there are no ground water wells located in the lower aquifer, but institutional controls are not permanent nor are they fully reliable. However, long-term impacts upon the environment are potentially substantial should contaminated water and NAPL migrate to, and discharge in, the Kootenai River. Additionally, the lower aquifer presents an environmental threat to the upper aquifer as well. Should the upper aquifer undergo an active remediation program, continued contamination in the lower aquifer may act as a source to recontaminate the upper.

Although no activity would be taken in conjunction with this alternative, applicable or relevant and appropriate requirements are the same as for the no-action alternative (1B) for the upper aquifer. There are no costs associated with this alternative. ARARs for this alternative would not be met.

Alternative 2C - Monitoring: The monitoring alternative consists of sampling deep wells located just outside the leading edge of the heavy oil pool near well #6004, sampling deep wells between #6004 and the Kootenai River, and sampling multiple completion wells located near the Kootenai River. The purpose of the monitoring program is to determine if oils are migrating further downgradient, determine if contaminated ground water is moving, and to monitor the potential for discharge of contaminated ground water to the Kootenai River.

Samples from wells will be collected and measured for conductivity, pH, temperature and dissolved oxygen. Field observations for visual appearance will be important to note if samples have a sheen, or NAPL present. Samples will be analyzed for various parameters including PAHs, Penta, VOCs, dibenzo-p-dioxins and dibenzofurans, and selected metals.

This alternative does not reduce contamination in the aquifer, so there is no difference in short and long-term human health and environmental impact from the no-action alternative. Ground water monitoring would provide the data to evaluate future human health or environmental risks.

Capital costs associated with this alternative are estimated to be $66,000, attributable to installation of additional monitoring wells. Annual O & M costs are estimated to be $32,000 per year for the next thirty years. Present worth cost of this alternative is $524,000. ARARs for the monitoring alternative are the same as for 1C, except that water well standards and well installation requirements under the authority of the Montana Department of Natural Resources and Conservation will be considered applicable. Certain ARARs for this alternative would not be met.

Alternative 3C - Institutional Controls: Institutional controls are those actions that would limit potential human contact with contamination from the lower aquifer. Currently, there are no private residential or commercial wells in Libby or the surrounding area that penetrate to a depth below the upper aquifer. This is because sufficient water production is achievable without drilling a deeper well. Also, as mentioned in alternative 3B, there is a City of Libby Ordinance prohibiting the construction of new water wells for consumption or irrigation. Institutional controls under this alternative consist of continuation of the Ordinance prohibiting new water well drilling, and if needed, passage of a similar control by Lincoln County for some areas which could be impacted by further contaminant plume migration.

Regulatory prohibitions precluding water well drilling and water use can be immediately effective in limiting human exposure to contamination. However, while institutional controls can be effective in protecting human health in the short term, they are not considered permanent or reliable remedies. Further, institutional controls have no affect upon contaminant migration and therefore cannot limit the potential environmental risks.

Capital cost to implement this alternative is estimated to be zero. Annual O & M costs are approximately $48,000 due to continued monitoring of ground water. The present worth cost for this alternative is estimated to be $737,900. The ARARs associated with this alternative are the same as for 1C. Certain ARARs for this alternative would not be met.

Alternative 4(C)1 - Oil Recovery and Treatment by On-Site Incineration, and Extended Ground Water Pump and Treat: Oil recovery would be accomplished through primary and thermal recovery techniques, and through additional ground water pumping. Although the remainder of the discussions for this and the next oil recovery alternative will focus on design and performance of the alternatives, the reader is referred to Appendix F of the FS Report for a more complete explanation. Specifically, that appendix describes the difficulties involved in the calculations, the inability to predict where oil traps will be located due to the extremely complex hydrostratigraphy, and the very uncertain assumptions inherent in alternative development.

The first phase of the implementation of this recovery system would be additional characterization of the heavy oil present in several known oil pools. It is estimated that 10 additional ground water monitoring wells would be needed for this task. After identification of the approximate locations of the largest oil pools, recovery wells would be installed on 100 foot centers. These recovery wells would be designed to recover heavy oil in each located reservoir. Primary recovery would be conducted in approximately 8 months. It is estimated that approximately 100,000 gallons could be recovered from all of the targeted reservoirs. It should be noted that this volume is estimated to be only 5% to 14% of the original oil in place.

After completion of the primary recovery system an enhanced thermal recovery operation would be initiated. This would entail the injection of steam in each reservoir to heat the oil, thus decreasing its viscosity and increasing the mobility of the oil in the soil environment, thereby increasing the amount of oil that can be recovered. Steam injection would involve the installation of surface facilities, including generators, steam strippers, heat exchangers and piping and pumps. Special wellhead equipment would be required for the steam injection wells. The same wells used for primary recovery would also be used for the thermal recovery and injection wells. Steam injection wells would be arranged to maximize efficiency of the steam flood. A 500-day life of the steam flood was calculated based on the time it would require to sweep five pore volumes of the reservoir. It is estimated that approximately 195,000 gallons of oil would be recovered by this thermal program, for a combined primary/thermal recovery of 295,000 gallons, approximately 15% to 40% of the original oil in place.

Oily water collected as part of the primary and thermal recovery steps would require a multi-stage treatment process, including organic/water separation and treatment of each recovered phase. Water phase from the oil/water gravity separator would be pumped to a dissolved air flotation (DAF) unit. Floating oil phase would be pumped to an interim storage tank. Water exiting the DAF unit would be pumped into a water treatment unit including fixed film bioreactors and effluent discharged to the ground water through a percolation bed (See alternative 5B).

After completion of the primary and thermal recovery programs the installation of a pump and treat system is believed to be the only available recovery technique to accelerate the dissolution of the oil in the aquifer and reduce the amount of contamination. Recovery pumps for this system would be installed in the four steam injection wells in each target pool. A total pumping rate of 500 gpm is assumed. It is calculated that approximately 182 years would be required to effectively clean up the aquifer contamination using this method.

Oil recovered by the three recovery techniques would be sent to storage tanks on-site. From the tank, oil would be piped to a fluidized bed incinerator (discussed in alternative 6A) at an approximate flow rate of 285 lb/hr. It is anticipated that destruction efficiency would be 99.9999% of organic contaminants. Incineration of the oil should be completed in less than one year.

This remedial alternative is considered to have limited short-term impact upon the lower aquifer. The relatively rapid withdrawal of 290,000 gallons of oil using primary and thermal techniques is considered of little significance in reducing overall impact upon the environment. Long-term effectiveness of this alternative is considered acceptable if the alternative is conducted until cleanup levels are achieved, approximately 182 years, an optimistic estimate. It is possible that oil recovery operations could increase ground water contamination due to dispersion of the oil throughout the aquifer during thermal recovery.

Capital costs to implement this alternative are estimated to be $5,571,100. Annual O & M costs are estimated to be the following: $505,200 for the second year; $1,300,100 per year for the next 3 years; and $32,200 per year for the next 25 years. The present worth cost for this alternative is estimated to be $9,163,600. Note that the costs have been developed based on a 30 year lifetime for comparison to other alternatives, however the actual lifetime of the system to achieve complete remediation has been estimated to be 182 years.

The major ARARs for this alternative are the same as for those alternatives using injection of treated ground water (4(B)1), and fluidized bed incineration (6A). In addition, RCRA technology standards for hazardous waste storage tanks would be applicable to this alternative. Monitoring requirements and institutional controls are considered integral parts of this remedy. ARARs for this alternative would be met, but only after the full treatment period was completed.

Alternative 4(C)2 - Oil Recovery and Treatment by Recycle/Reuse, and Extended Ground Water Pump and Treat: This alternative is in almost all respects the same as alternative 4(C)1, except that recovered oil would be reconditioned for possible reuse. Therefore, only the oil treatment method is discussed in the following sections, along with the changes in costs and significant ARARs.

Under this alternative, no further treatment of recovered oil would be conducted other than separation from water and filtration to remove suspended particulates. Separated oil would be periodically pumped through an in-line filter to a tank truck and hauled to storage tanks or a customer site, if the product can be resold. Spent filter cartridges or filter media from this system would be crushed and land treated on site with soils in the land treatment unit.

Capital cost required to implement this alternative is estimated to be $2,948,700. Annual O & M costs are estimated to be the same as for alternative 4(C)1 for the first five years. Annual O & M costs for the next 25 years are estimated to be $32,000. The estimated present worth cost for this alternative is $7,206,700.

ARARs for this alternative are similar to those for alternative 4(C)1, except there will be no incinerator ARARs. However, there will be RCRA ARARs for hazardous waste generators and transporters, and DOT manifesting requirements, since waste may be taken off-site. If hazardous substances are disposed off-site, rather than recycled and reused, Section 121(d) of CERCLA will have to be complied with.

Alternative 5C - In-Situ Bioremediation of the Lower Aquifer: Chapter 5 of the FS report evaluated aquifer biorestoration as a technology potentially applicable to the ground water contamination in the lower aquifer. However, biodegradation of product is considered to be a much more difficult process than the biodegradation of dissolved or adsorbed contaminants, as are primarily found in the upper aquifer. The primary problem is it is difficult to build up the biological activity to a sufficient concentration to begin contaminant degradation. Because of the complex problems associated with application of the technology to the lower aquifer, the focus of the FS report was concentrated on oil extraction methods using oil field technology. As demonstrated in the description of alternatives 4C(1) and 4C(2), product extraction and ground water treatment using conventional technology at the Libby site would be very expensive and not very effective in either the short term or long term. Therefore, EPA is evaluating in-situ bioremediation in this remedy selection as another alternative, based upon information in the FS Report and the administrative record.

Application of this process to the lower aquifer would be in theory similar to alternative 5B. Implementation of this alternative would require extensive field testing and design considerations, because: (1) the hydrostratigraphy of the system is very complex, (2) successful testing would require isolation of a product pool which could be evaluated for biodegradation effectiveness through time, (3) less is known about contaminant transport in the lower system, due primarily to the shortage of wells and inconclusive aquifer (pump) tests.

While remediation of the lower aquifer has focused on the problems associated with oil removal or degradation, EPA feels that a combination of oil recovery and product dispersion, with biodegradation, is the only potentially viable cleanup method. In order for biorestoration to be effective, it will be necessary to remove as much product from the aquifer as possible. Additionally, secondary or tertiary oil recovery techniques may then be used to facilitate biorestorative processes. For instance, it has been documented in Appendix F of the FS Report that thermal removal of oil may disperse contaminants throughout the aquifer, into matrix pores. This deconcentration of product would allow biologic activity to occur more rapidly because of the greatly increased contaminant surface area.

Bioremediation, even in conjunction with oil recovery technologies, could potentially be as or more effective than traditional pump and treat aquifer solutions, and much less costly. Without the benefit of field testing estimates of short or long-term effectiveness are not possible. Costs to implement such an alternative are also unknown, but it is believed that an objective, well-developed field program, to be conducted for two years, would require between $300,000 and $500,000. ARARs for an in-situ bioremediation alternative are the same as for alternative 5B. ARARs for this alternative would be met if the technologies prove successful and the program is implemented in full. ARARs would not be met for the pilot testing program necessary at this time.

IX. Summary of Comparative Analysis of Alternatives

All of the remedial action alternatives which passed an initial screening process were subjected to a detailed evaluation in accordance with OSWER Directive 9355.0-19 and Section 300.68(h) of the National Contingency Plan. Alternative 5C was also evaluated against these criteria, and that evaluation is reflected in the administrative record and this document. The detailed analysis was conducted using nine criteria developed to assure remedy selection compliance with Section 121(b)(1)(A-G) of CERCLA. The following sections will briefly compare the alternatives within each sub-action to the evaluation criteria.

Further information is available in Chapter 8 of the FS report and other documents in the administrative record.

Sub-Action A - Soils/Source Areas

1. *Overall Protection of Human Health and the Environment:* Alternatives involving land treatment, with and without a liner, incineration, and the soils/slurry bioreactor are all considered fully protective of human health and the environment. Each remedial action minimizes the potential exposure pathways by reducing the number of areas in which contamination will be found and by covering the final disposal area with an impermeable cover. The land treatment with a liner alternative is slightly more protective of the environment in that the bottom synthetic liner will provide another protection against contaminant leaching. As a stand-alone alternative, capping of existing contamination areas is considered less protective of human health and the environment because of the greater potential for continuing contaminant leaching to the environment. Institutional controls can help to prevent direct human exposure to contaminants, but the environmental threat due to contaminant leaching is even more substantial than for the capping alternative. The no-action alternative is not protective of human health or the environment.

2. *Compliance with Applicable or Relevant & Appropriate Requirements:* Alternative 6A, incineration, is the treatment alternative compliant with ARARs if air quality standards can be met. Both land treatment alternatives and the soil/slurry bioreactor may require a demonstration of no-migration to obtain a variance from the land disposal restrictions so that treatment can continue until cleanup criteria are reached, but these will also meet ARARs. A variance from the land disposal restrictions based on no-migration should be easier to obtain if a lining system is used in a land treatment unit. Because incineration would reduce organic contamination to below established BDAT for the restricted wastes, prior to placement in a land disposal unit, it will be in full compliance with the land disposal restrictions. The capping alternative can also be conducted in accordance with all ARARs involving technology standards and closure/post-closure requirements. Excavation of contaminated areas would meet ARARs. ARARs would not be met for the no-action and institutional control alternatives.

3. *Long-Term Effectiveness and Permanence:* Alternatives using incineration, land treatment and the soil/slurry bioreactor are all effective remedies which will provide long-term protection of human health and the environment because the majority of contaminants will be destroyed and the remainder immobilized. Each alternative reduces contaminant levels to a great extent, and the remedies are considered permanent because there will be only residual contamination left and the cover will require

routine maintenance. Capping alone can provide some long-term protection but it is not considered a permanent remedy because the primary protection (cap) is subject to failure and treatment is not part of the remedy. The impacts of cap failure for this alternative are much greater than for cap failure of any of the treatment alternatives because contaminant levels will still remain high and therefore pose a threat to human health and the environment. Neither institutional controls nor the no-action alternative are considered permanent solutions and neither provide long-term protection.

4. *Reduction of Mobility, Toxicity, or Volume*: All of the treatment alternatives significantly reduce the toxicity of contaminated soils through contaminant destruction. Both land treatment alternatives and the soil/slurry bioreactor reduce the mobility of contaminants through treatment and isolation in a disposal area. Land treatment with a liner system decreases the potential for contaminant mobility even more through engineering controls. Incineration can ultimately reduce the mobility of contaminants, although emissions releases may mobilize some constituents. Incineration will reduce the volume of contaminated materials; land treatment and the soil/slurry alternative will only reduce volumes slightly through organic carbon destruction. Capping will reduce contaminant mobility, but not in a permanent manner. The no-action alternative and institutional controls will not reduce MTV.

5. *Short-Term Effectiveness*: The capping alternative would provide the most immediate short-term alleviation of public health and environmental threat by rapidly reducing the opportunity for contaminant exposure. Among the treatment alternatives, incineration could be completed within one year after pilot start-up, while the soil/slurry bioreactor would take approximately 2 years to reduce contaminants to acceptable levels and the land treatment alternatives would take 4 to 6 years. All three treatment alternatives would create other, short-term exposure potentials via excavation and movement of contaminated soils and volatile or combustion emissions. Institutional controls can help to quickly reduce potential for public exposure to contaminants. The no-action alternative is not effective.

6. *Implementability*: The no-action alternative and institutional controls are the most easily implemented alternatives considered. Capping technology is well developed and the materials and services required are available. The land treatment alternatives are the most readily implemented of the treatment actions being considered because the technology is well understood and the bench scale and pilot scale tests at Libby have provided needed design criteria. The soils/slurry bioreactor technology is available but demonstration would be required to evaluate rate of effectiveness and refine design criteria. Mobile incineration units are available, but extensive

demonstration of combustion efficiencies make this possibly the least easily implemented alternative. Air problems specific to the Libby area may negatively effect incinerator implementability.

7. _Cost:_ Table 13 provides a comparison of the costs for the soils and source areas remedial alternatives. The no-action alternative would require zero expenditure, while institutional controls would require minimal capital and annual costs. Of the active alternatives, land treatment without a liner would require the least capital outlay, followed by capping of source areas, land treatment with a liner, the soils/slurry bioreactor and the most expensive alternative, incineration. Incineration, soil/slurry bioreactor and the land treatment alternatives all have similar annual O & M cost requirements for most of the thirty year lifetime, although the land treatment alternatives will require extensive operations costs during years 2 through 5. Annual O & M costs for capping are approximately 50% higher than the other, active alternatives. Of the treatment or containment alternatives, land treatment without a liner is predicted to have the lowest present worth cost, followed by capping, land treatment with a liner, soils/slurry bioreactor and finally incineration. [Note: All costs presented are estimates]

8. _State Acceptance:_ The State of Montana has concurred with the remedy selection for this sub-action. The State has agreed that a liner is a necessary element of the land treatment unit. One recommendation the State of Montana has made is that institutional controls prohibiting residential development, in soils clean up and treatment areas, be included as a required element of the remedy. This prohibition has been included.

9. _Community Acceptance:_ Specific comments submitted by the public during the public comment period, and Agency responses to those comments, are attached as part of the Responsiveness Summary Section. The following summarizes some of the concerns raised by the public over the methods considered for soils/source areas clean up.

Some members of the audience at the public meeting questioned the effectiveness of removing only the soils/source materials in the unsaturated zone. They felt that most of the contamination would be deeper than the water table. Another concern of some citizens is that institutional controls can be a violation of individual property rights. One commenter also mentioned that use of a cap over the treatment areas is a waste of time since the ground water flow would continue to spread contamination. However, there were no comments directed at the alternative selection, and EPA therefore believes that in general the community is accepting of the preferred alternative.

Sub-Action B - Ground Water Treatment, Upper Aquifer

1. *Overall Protection of Human Health and the Environment:* Technical evaluation of ground water clean up alternatives indicates that treatment alternatives using pump and treat technology and in-situ bioremediation can all adequately protect human health and the environment by eliminating contaminants, and thus exposure risk, from the aquifer. Institutional controls can provide some protection to human health by limiting exposure, but it provides no environmental protection. Monitoring and the no-action alternative provide no protection to human health or the environment.

2. *Compliance with Applicable or Relevant and Appropriate Requirements:* All of the ground water treatment alternatives can be implemented to assure compliance with all potential ARARs, except potentially for the Montana Non-Degradation rules for ground water. In order to achieve compliance with this ARAR, off-site pumping of contaminated ground water may have to occur to halt ground water plume migration. This opinion is based on the assumption that ground water plumes are migrating, and that the Montana Water Quality Bureau will consider plume migration a non-degradation rule violation. Without an off-site pump system, the treatment response actions would have to be placed on a compliance schedule and this would achieve compliance with the Statute. The institutional controls, monitoring and no-action alternatives would not achieve compliance with many ARARs, including MCLs (benzene) established by the Safe Drinking Water Act; Montana non-degradation laws for ground water; and, if plumes migrate to the Kootenai River and/or Flower Creek, Montana rules on non-degradation of surface waters.

3. *Long-Term Effectiveness and Permanence:* Alternatives 4B(1), pump and treatment of ground water using a rotating biological contactor, and 5B, in-situ bioremediation, provide long-term remediation effectiveness. These remedies are considered permanent in that they degrade/destroy contaminants to acceptable cleanup levels. Alternative 4B(2), pump and treatment of ground water using granular activated carbon, provides long-term relief from ground water contamination, but the remedy is not considered as permanent because contaminants are not destroyed but transferred to a different media (activated carbon) which will then require thermal regeneration. Institutional controls, monitoring and no-action alternatives will not provide long-term protection of human health and the environment.

4. *Reduction of Mobility, Toxicity or Volume:* The in-situ bioremediation alternative and pump and RBC treatment alternative both reduce mobility, toxicity and volume of contaminants in the ground water. Pump and GAC treatment alternative will reduce mobility and toxicity in the ground water, but contaminants are transferred to another media. Institutional controls, monitoring

and the no-action alternatives will not reduce MTV.

5. *Short-Term Effectiveness:* In-situ bioremediation is the most effective treatment alternative in the short-term because it is estimated that this response action could be completed in 3 to 5 years, depending upon required cleanup levels. Both pump and treat alternatives would require approximately 10 years to be effective. Institutional controls provide an effective short-term remedy in that they can reduce the potential for human exposure immediately. Monitoring and no-action alternatives do not achieve a level of protectiveness, and are therefore not effective.

6. *Implementability:* No-action and monitoring alternatives are very easily implemented since no additional design, construction or procurement actions would be required. Institutional controls are already in place in Libby, although some expansion of the buy-water plan may be required. Additional institutional controls could be implemented relatively easily for areas outside the city of Libby. Of the three treatment alternatives, in-situ bioremediation is probably the most easily implemented because equipment is available and operational knowledge was gathered during site pilot testing.

7. Cost: Table 15 presents a comparison of the costs required to implement and maintain the considered alternatives. The no-action alternative requires no capital or O & M expenditures. Institutional controls are the least expensive of the other alternatives to implement, and monitoring is next. Annual O & M costs and present worth costs of these two alternatives are also much lower than any of the treatment alternatives. The least costly treatment alternative to implement is in-situ biodegradation, followed by pump and treat with RBC and then pump and treat with GAC. Annual operating costs for the in-situ alternative are also lower, and for fewer years, than the pump and treat alternatives. Annual O & M costs for all three are about the same once the desired cleanup has been achieved. In-situ bioremediation is also valued less in terms of present worth cost than the other treatment alternatives. [Note: All costs presented are estimates]

8. *State Acceptance: The State of Montana has concurred with the selection of In-Situ Bioremediation as the preferred clean up alternative for the upper aquifer.*

9. *Community Acceptance:* Specific comments submitted by the public during the comment period, and Agency responses to those comments, are included with this remedy selection as part of the Responsiveness Summary. The following summarizes some of the public concerns over the methods considered for ground water clean up.

Some citizens at the public meeting were worried about the impact that high volume pumping wells could have on residential wells in the vicinity. Another citizen questioned what would happen to the ground water bacterial populations after clean up. Many individuals stressed the need for the buy-water plan to be extended, if ground water plumes migrate, to newly impacted residences. However, there were no negative comments directed at the preferred alternative, and EPA therefore believes that the community is accepting of the recommended remedy.

Sub-Action C - Ground Water Treatment, Lower Aquifer

1. *Overall Protection of Human Health and the Environment:* Institutional controls provide the most immediate and most assured protection of human health of the alternatives considered for this sub-action, but this protectiveness is considered neither permanent nor reliable. Oil recovery options, when combined with a ground water pump and treat scenario, may some day provide protection of human health and the environment. At the least, extensive pump and treat could prevent contaminants from migrating to the Kootenai River. The additional alternative considered in this remedy selection, in-situ bioremediation, may also provide protection of human health and the environment if it is proven to effectively degrade contamination in the aquifer. The monitoring and no-action alternatives are not protective.

2. *Compliance with Applicable or Relevant and Appropriate Requirements:* In order to be fully compliant with potential ARARs an alternative which halts plume migration would have to be implemented (see discussion on ARARs compliance in the upper aquifer and non-degradation issues) and MCLs would have to be achieved throughout the aquifer. Oil recovery and treatment (through incineration or recycle) with extended ground water pump and treatment are the only alternatives evaluated in the FS Report which could achieve compliance. Monitoring, institutional controls and no-action alternatives may all violate benzene MCL and non-degradation policies. The in-situ bioremediation alternative may achieve ARARs, if implemented in full. A pilot program evaluating in-situ bioremediation and other aquifer remediation techniques would not meet ARARs, but would be eligible for a waiver of ARARs as an interim remedy.

3. *Long-Term Effectiveness and Permanence:* The in-situ bioremediation alternative could theoretically provide long-term effective protection of human health and the environment. This alternative would also be considered a permanent remedy because contaminant levels would be degraded in-situ until established cleanup levels are reached. However, an in-situ biorestoration program may also take a long time to reach desired cleanup levels. Oil recovery and treatment alternatives could eventually provide long-term protection, but treatment would require an estimated 180+ years to achieve desired protectiveness levels.

Institutional controls, monitoring and no-action are not considered effective in the long-term.

4. *Reduction of Mobility, Toxicity or Volume:* An in-situ bioremediation program could reduce mobility, toxicity and volume of contamination if effective at reducing oil concentrations. Oil recovery and treatment options may reduce volume of contamination and eventually toxicity, but thermal recovery methods in situ may actually increase the mobility of some contaminants. Institutional controls, monitoring and no-action are all equally ineffective at reducing MTV.

5. *Short-Term Effectiveness:* Institutional controls would provide the most immediate and assured protection from exposure to lower aquifer contamination. No-action and monitoring alternatives will not help achieve protection and are therefore not effective. Oil recovery effectiveness would be limited in the short-term, and adverse environmental effects could actually be a result of implementation of this alternative through contaminant mobilization. Mobilization of the contaminants could also enhance biodegradation processes, however. In-situ bioremediation alone would not be as effective in the short-term for the lower aquifer as the upper because of the presence of large amounts of product in the lower aquifer. Further evaluation of this criterion for an in-situ bioremediation program could only come after pilot testing.

6. *Implementability:* The no-action, monitoring and institutional control alternatives are very easy to implement quickly and inexpensively. Implementation of the oil recovery options would be difficult. Extensive design would have to be conducted in conjunction with field investigations including an intensive drilling program. Specialized equipment would have to be created for the steam injection wells. Alternative 4C(1), which utilizes incineration of recovered oils, would be restricted by the same design criteria as for the soils incineration alternative previously discussed. An in-situ bioremediation alternative (5C) could theoretically be implemented much easier than pump and treat scenarios, but extensive design work and modeling to determine engineering controls would have to be conducted. Also, because an in-situ program would probably be combined with oil recovery, implementation requirements may be quite similar.

7. *Cost:* Table 17 presents a summary and comparison of the costs required to implement and maintain the alternatives considered for operable unit C. (Note that costs for alternative 5C are not included in the table). The no-action scenario would require zero capital or O & M expenditures. Lower aquifer monitoring would require some capital outlay to install new monitoring wells. Annual O & M costs for the monitoring alternative are lower than for institutional controls, which

would require no capital outlay. Alternatives requiring oil recovery are similar in cost, except that incineration costs would increase number 4C(1) by over $2.5 million initially. The present worth cost of the oil recovery and incineration alternative is therefore greater than the oil recovery and recycle/reuse alternative. Addition of extended pump and treat ground water systems to either of these alternatives (necessary for ground water cleanup) would dramatically increase costs. Because alternative 5C is considered a conceptual alternative which requires laboratory and field testing to prepare an effective analysis, costs have not been included in this evaluation. However, EPA suggests that a well designed pilot study of this alternative for the lower aquifer would cost approximately $300 to $500 thousand dollars. [Note: All costs are estimates]

8. *State Acceptance:* The State of Montana has concurred with the decision to make the remedy selection for the lower aquifer an interim remedy. The State has agreed that field and laboratory tests should be conducted to evaluate the effectiveness of in-situ bioremediation, in conjunction with oil recovery techniques, for the lower aquifer.

9. *Community Acceptance:* Specific comments submitted by the public during the public comment period have been addressed by EPA and responses to those comments are included as part of the Responsiveness Summary attached to this remedy selection. In general, there has been no community feedback concerning either the alternatives considered or the preferred alternative for the lower aquifer. The EPA therefore believes that the public is generally accepting of the recommended remedy.

X. Selected Remedies and Cleanup Determinations

Soils/Source Areas Excavation and Clean Up and Treatment Criteria

- The alternative preferred by EPA to remediate contaminated soils and sources areas is number 5A(1), Excavation of Contaminated Soils and On-Site Land Treatment With a Liner. As developed in the FS Report, this alternative combines an innovative treatment technology, enhanced in-situ biodegradation, with traditional land farming to effectively reduce soil contaminant concentrations. Contaminated soils located in the unsaturated zone will undergo a two-step enhanced biodegradation treatment. Initial treatment will be conducted in the waste pit area. Upon reaching an optimum contaminant degradation lifts of soils will be transferred to the second phase, lined treatment cell, which will also act as the final disposition location.

A combination of bioremediation treatment processes will be utilized to degrade organic compounds in soils in the saturated zone. A closed loop, nutrient and oxygen-rich ground water injection and extraction system will be the primary technique used to degrade contaminants adsorbed on soil matrices and in oil product in the saturated zone. Ground water extraction and physical treatment will speed the process. This system should effectively halt any further contaminant migration outside of the waste pit area.

Determination of excavation and treatment criteria for soils has been conducted using two methods: (1) Evaluation of the standards supplied in various ARARs, such as BDAT concentrations in the Land Disposal Restrictions, and (2) using human health risk assessment to determine contaminant concentrations which are protective of human health, while giving consideration to site-specific conditions. Land disposal restrictions are discussed in detail in the Feasibility Study Report, Section 4.5.2. Cleanup criteria for certain compounds have been evaluated in Section 4.7 of the FS Report. EPA has determined that the following cleanup levels and treatment levels are protective of human health and the environment and are in compliance with ARARs, and the remediation activities for soils and source areas will be required to meet these levels.

1. *Excavation of Butt Dip, Tank Farm and Waste Pit Areas:* These areas will be excavated to an acceptable cleanup level, defined as: All soils, debris or other "source" material from these areas which are contaminated with concentrations of carcinogenic PAH compounds greater than 88 milligrams per kilogram (mg/kg) will be removed and treated to the (see below) treatment levels. This level have been chosen because: (1) 88 mg/kg of carcinogenic PAHs is selected as the "indicator" cleanup level because it should provide a relatively good visual identifier of contamination; (2) PAHs are ubiquitous in these three areas and, based on extensive site investigations, if they are not present, other contaminants should not be; and, (3) if carcinogenic PAHs are present below the cleanup level, risk analysis indicates the potential human health threat will be acceptable (10^{-5} risk construction scenario), and backfilling and capping of the areas will reduce the potential for exposure to the residual contamination and meet relevant and appropriate RCRA closure requirements. A sampling and analysis program will be developed to assure concentrations remaining in or near excavation areas do not exceed these cleanup/treatment levels.

2. *Contaminant Levels Prior to Placement in the Final Land Treatment Unit:* Because of a capacity extension, land ban concentration levels for the placement of waste soils into the final treatment unit do not need to be met prior to August 8, 1990. If it is determined that the land ban concentration levels cannot be met after this date, a no-migration petition will be prepared, using data from the 1988 land treatment demonstration unit and, if possible, from the 1989 field season.

3. *Treatment Levels for Excavated Soils:* Soils, debris or other "source" material from the waste pit, butt dip and tank farm areas will be treated to an acceptable cleanup level, defined as: (1) Total carcinogenic PAH concentrations are less than or equal to 88 mg/kg; (2) Individual PAH compounds napthalene, phenanthrene and pyrene, will be less than or equal to 8.0 mg/kg, 8.0 mg/kg, and 7.3 mg/kg, respectively; (3) 2,3,7,8-TCDD equivalency concentrations of chlorinated dibenzo-p-dioxins and dibenzofurans combined are less than or equal to 0.001 mg/kg; and (4) Pentachlorophenol concentrations are less than or equal to 37.00 mg/kg. PAH and 2,3,7,8-TCDD equivalency concentrations were developed using cumulative target risk calculations to determine an acceptable range of risks using different land use scenarios. The 88 mg/kg treatment/cleanup level represents a 10^{-5} risk using a construction exposure scenario. The additive risk using a residential exposure scenario, although not calculated exactly, would be slightly less than 10^{-4} (within the acceptable range of risk). The residential scenario is considered highly unlikely for the Libby site and institutional controls will prohibit residential development in waste areas. The pentachlorophenol concentration was selected because the applicable BDAT concentration for land disposal restriction of this compound is 37.00 mg/kg, which is a relevant and appropriate requirement for the end of treatment. This number is also consistent with 40 CFR Part 264, Subpart M requirements, which require maximum destruction of contaminants in a land treatment unit. Individual treatment concentrations were also selected for napthalene, phenanthrene and pyrene, based on the BDAT treatment concentrations. After August 8, 1990, if the treatment concentrations for penta, or napthalene, or phenanthrene, or pyrene cannot be achieved prior to placement in the land treatment cell, a no migration variance will satisfy the land disposal requirements.

4. *Treatment Levels for Materials in the Saturated Zone:* Treatment levels in the saturated zone will be based upon leachate concentration. In other words, ground water exiting the saturated zone below the waste pit area will be required to be at concentrations less than or equal to the ground water cleanup levels established in the following section. Compliance with this requirement will be monitored by analysis of samples collected at waste pit area extraction wells.

Institutional controls, during the treatment activities and after completion of capping, will be required as part of this remedy.

Ground Water Cleanup Levels - Upper Aquifer

The alternative preferred by EPA to remediate contaminated ground water in the upper aquifer is number 5B, In-Situ Ground

Water Bioremediation. As developed in the FS Report, this alternative should effectively treat ground water contamination in place, an innovative approach considered more effective than other traditional ground water clean up options. The closed loop treatment process described in the soils treatment alternative will reduce further contamination of the ground water by retarding leaching of contaminants from the waste pit source area. An in-situ, enhanced biorestoration program, separate from the processes employed to degrade contamination in the saturated zone of the waste pit area, will be initiated in the upper aquifer to begin reducing contaminant levels near the tank farm and in downgradient regions.

Ground water cleanup criteria have been determined by examining and considering pre-established, ARAR standards such as Safe Drinking Water Act Maximum Contaminant Levels; use of human health risk assessment to determine contaminant concentrations which are protective of human health; and, when necessary, technology limited values. 10^{-6} target risks have been calculated for certain compounds in Section 4.7.1 of the Feasibility Study Report. Section 4.3 of the FS Report discusses the potential ground water ARARs, and Section 4.6 discusses other criteria, advisories and guidance which were considered in determining the cleanup levels.

EPA has determined that ground water cleanup levels will be the following for the upper aquifer: (1) Total non-carcinogenic PAH compounds in ground water will be present in concentrations no greater than 400 nanograms per liter (ng/L) and carcinogenic PAH compounds will be present in concentrations no greater than 40 ng/L. The carcinogenic PAH concentration has been based on risk calculations presented in the FS report and achievable detection limits, because the determined 10^{-6} target cleanup level is not reliably detectable using current analytical technology. The risk presented by leaving this concentration of carcinogenic PAH in ground water is 10^{-5}. The carcinogenic PAH concentration of 40 ng/L is not a level uniformly detected at many analytical labs at the present time. Rather, it represents a number which some laboratories state can be achieved at the present time, and which should be more reliably achievable through time. Therefore, sampling and analysis of ground water samples to determine compliance with cleanup goals will have to be conducted under strict protocol. The clean up level for total non-carcinogenic PAH concentrations is based on evidence that many creosote compounds are capable of promoting the carcinogenic activity of other, cancer causing compounds. Because the carcinogenic PAHs clean up level is higher than a 10^{-6} risk level, and because a newly listed carcinogen (penta) will be present in concentrations most probably higher than normal for such a compound, EPA believes that a conservative clean up level for total PAH compounds is warranted. This decision is further justified as a means to assure that other potentially hazardous creosote compounds, not typically analyzed for during the Libby site investigations, will be destroyed to acceptable concentrations as well. (2) Pentachlorophenol will be present in concentrations no greater than 1.05 milligrams per liter (mg/L). This concentration is based on a lifetime health advisory. (3) Benzene will be present in concentrations no greater than 5 micrograms per liter (ug/L). (4) Arsenic will be present in concentrations no greater than 50 ug/L. Arsenic and benzene concentrations were selected based on Maximum Contaminant Levels established by the Safe Drinking Water Act. (5) Finally, other organic and/or inorganic compounds which may be present in the ground water will be at concentrations which pose a human health threat no greater than 10^{-5}.

Attainment of cleanup levels for the compounds used as ground water indicators (above) should assure that other organic or inorganic compounds will not be present in concentrations potentially harmful to public health and/or the environment. For instance, volatile organic compounds such as methylene chloride and tetrachloroethylene have been detected in some aqueous samples. As already noted, creosote contains many organic compounds which have not typically been looked for in Libby samples. Treatment to reduce the primary contaminants, Penta and PAH compounds, should effectively reduce these other chemicals to acceptable concentrations. However, cleanup level #5 above assures that overall ground water cleanup will achieve a target human health risk not greater than that created by the analytical technology limited PAH target level.

Institutional controls and monitoring are also required in conjunction with this remedy. When acceptable levels are achieved, institutional controls can be discontinued. Monitoring will be required as long as hazardous substances remain.

Ground Water Cleanup Levels - Lower Aquifer

Because none of the alternatives presented for clean up of the lower aquifer have been demonstrated to effectively reduce contaminant concentrations in a reasonable timeframe, EPA has decided that a test of in-situ bioremediation, in conjunction with oil recovery/dispersion techniques, should be attempted. This feasibility testing of remediation technologies is selected as an interim remedial measure. A final remedial measure will be chosen at the conclusion of the pilot program. This remedial measure is included in the descriptions as alternative number 5C. A biorestoration test program similar in scope to that conducted for the upper aquifer will be initiated. The pilot test will be conducted to determine if enhanced biorestoration of the aquifer, alone and in conjunction with oil recovery techniques, is a viable means of aquifer cleanup. In conjunction with this remedy, institutional controls and continued monitoring are required which will provide protection of human health and the environment at this time. ARAR requirements are waived on a temporary basis and will be re-evaluated during the next record of decision.

Treatment of the ground water in the upper and, if required, lower aquifers will be continued until the cleanup levels are attained and maintained through time. Once cleanup levels are attained, it is anticipated that treatment will continue for some as yet unspecified period. This will assure residual or delayed-release contaminants are not re-entering the system. Monitoring of ground water quality will continue after acceptable contaminant levels have been attained and maintained, and remediation has stopped.

The Statutory Determinations

The remedy selected for each operable unit must satisfy the requirements of Section 121 of CERCLA. Specifically, Section 121(b) of CERCLA requires that any selected remedy be protective of human health and the environment, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(d) of CERCLA states that remedial actions that leave any hazardous substance, pollutant or contaminant on-site must meet, upon completion of the remedial action, a level or standard of control that at least attains standards, requirements, criteria or limitations that are legally applicable to the hazardous substance, pollutant, or contaminant concerned, or are relevant and appropriate under the circumstances of the release or threatened release. Section 121(d) allows EPA to waive these requirements under certain limited conditions.

EPA has concluded that the selected remedy is consistent with these requirements of CERCLA. The following section provides a narrative description of how the selected remedy meets the specific statutory requirements.

Protection of Human Health and the Environment

Soils excavation and contaminant biodegradation will dramatically reduce risks to human health and the environment. Excavation of contaminated soils from the butt dip and tank farm areas will centralize all source materials in the waste pit area. The butt dip and tank farm excavations will be backfilled and closed with a protective cap to assure there is no residual contamination exposure potential via soils contact or ingestion. Treatment will be conducted in the waste pit area until a specified level of degradation is reached; materials will then be transferred to the lined land treatment unit and disposal cell. After excavation of partially treated soils from the waste pit the area will be backfilled and closed with a protective cap to reduce residual contamination exposure potential. Final treatment will be conducted in a land treatment unit, which will be designed to control runoff, prevent runon, and halt downward contaminant migration. Soils treatment will continue until an acceptable level of cleanup (see previous sections) is achieved. This cleanup level is considered by EPA protective of human health and the environment. As an assurance, a protective cap will be placed over the land treatment area upon treatment completion.

Environmental risks posed by soils contamination are primarily through leaching of contaminants into the ground water. The remedies selected will dramatically reduce the leaching potential by removal of soils from some uncontrolled areas and by establishing a closed-loop treatment cell at the waste pit area to assure contaminants in the saturated zone are treated and cannot migrate further downgradient. There should be no environmental risks posed by the land treatment unit. In order to assure contaminants will not migrate from the cell, and to ensure compliance with ARARs, a demonstration of no-migration will be done. The basis for this demonstration will be extensive technology field testing conducted on site during the summer of 1988, including air emissions sampling and modeling, and engineering controls as needed to assure contaminant migration prevention, including a liner system.

Existing institutional controls will continue to prevent human exposure to contaminated ground water in the upper aquifer until acceptable contaminant levels are reached. The in-situ bioremediation alternative selected will provide long-term protection of human health and the environment by degrading contaminants within the aquifer system. This ground water treatment alternative will be conducted until levels considered protective of human health and the environment are achieved. Monitoring will be conducted to ensure protective levels are maintained.

Institutional controls will continue to prevent human exposure to contaminated ground water in the lower aquifer during the pilot program and beyond. Monitoring will be conducted to assure continued environmental protection. The final remedial action, to be decided upon completion of the pilot program, will address protectiveness again. If the test program is not effective, monitoring and institutional controls may be relied upon to prevent human exposure and identify environmental threats.

Implementation of the remedies selected should not create unacceptable short-term risks or adverse cross media impacts.

Attainment of ARARs

The remedies selected for soils clean up and the upper aquifer, coupled with a no migration petition, will attain all applicable or relevant and appropriate requirements. The Hazardous and Solid Waste Act requires BDAT treatment of K001 sludge prior to land disposal. Because land treatment is considered a form of land disposal, and because the contaminated soils are K001 soil and debris once mixed in the waste pit, these requirements are considered applicable to the placement of waste in the final treatment cell. It is unknown at this time whether land treatment at the Libby site will reduce concentrations of contaminants to below BDAT concentrations, so that the land disposal restrictions would eventually be met. However, because placement will probably occur after August 8, 1990, a demonstration of no-migration petition will be prepared and submitted to EPA to allow continued use of the innovative biodegradation technology at the Libby site. This will comply with the land disposal restrictions.

Also, as noted earlier in this document, ground water non-degradation ARARs may not be met should plumes in either aquifer continue to migrate. However, migration is not expected and the upper aquifer remediation should result in compliance for that aquifer. A waiver of relevant and appropriate requirements of the Safe Drinking Water Act and other ARARs for the lower aquifer is invoked based on technical impracticability and the fact that this is an interim remedy which may achieve compliance.

Tables 18, and 19, list the ARARs identified for the remedies selected.

There are some potential ARARs which are worth noting in this decision document because they could potentially impact remedy implementation in the future. They are all compound-specific issues.

A change in the MCL for arsenic is anticipated to be proposed in late 1988. The new concentration could be as low as 0.02 mg/L, as opposed to the current MCL of 0.05 mg/L. The proposal would be based on revised determinations of what concentrations of arsenic present an unacceptable risk to public health in ground water. Should this MCL be promulgated prior to finalization of the ROD it will be considered relevant and appropriate to the Libby site, and the arsenic ground water cleanup criterion will be the new MCL.

A change in the MCL for tetrachloroethylene is anticipated to be proposed in late 1988. The new concentration could be as low as 0.005 mg/L. Should this MCL be promulgated in final form prior to finalization of the ROD it will be considered relevant and appropriate to the Libby site, and the tetrachloroethylene

Table 18

Applicable or Relevant and Appropriate Requirements

Soils/Source Areas Action

The following requirements have been identified as applicable or relevant and appropriate to the response action selected for clean up of contaminated soils and sources areas on the Libby site. Specific citations for United States and State of Montana statutes and regulations are provided, along with a distinction between "applicable" and "relevant and appropriate." In some instances, comments are provided for further information. These ARARs have been identified on the basis of preliminary design criteria for the selected alternative, land treatment with a liner. Final remedial design may reveal other response action ARARs which should be taken into consideration for remedial action. The site administrative record contains extensive documentation on ARARs, and it should be reviewed for more insight into the identification and selection process.

Statute or Regulation/Citation	Applicable or Relevant and Appropriate	Comment
Executive Order 11990 40 CFR Part 6	Applicable	
Clean Water Act, Section 404, 40 CFR Parts 230 & 231	Applicable	
Endangered Species Act 50 CFR Parts 200 & 402 .	Applicable	
Resource Conservation & Recovery Act, 40 CFR Part 264, Subparts F, G, K, L, M & N	Applicable and Relevant and Appropriate	Old and New Units
40 CFR 264.111	" "	" "
40 CFR Part 268 & RCRA Section 3004	Applicable	

Table 18 Continued

Statute or Regulation/Citation	Applicable or Relevant and Appropriate	Comment
Occupational Safety and Health Act 29 CFR 1926, Sub-Part P, and 1910	Applicable	
Ambient Air Quality ARM 16.8.807, 809, 811, 814-822	Applicable	
Prevention of Significant Deterioration of Air Quality ARM 16.8.925, 933, 928, 931,	Applicable	
Visibility Impact Assessment ARM 16.8.1003, 1004, 1007, & 1008	Relevant and Appropriate	
Air Quality Permit ARM 16.8.1105	Applicable	Only Substantive Requirements
Emissions Standards ARM 16.8.1427	Applicable	
General Air Quality MCA 75-2-102, 201	Applicable	Policy Statement
Non-Game and Endangered Species ARM 12.5.201	Applicable	
MCA 87-5-501	Applicable	Policy Statement
Historical Preservation ARM 12.8.501	Relevant and Appropriate	Policy Statement
ARM 12.8.505, 506 507, 508	Applicable	
MCA 22-3-433, 435	Applicable	

Table 18 Continued

Statute or Regulation/Citation	Applicable or Relevant and Appropriate	Comment
Solid and Hazardous Waste Management		
ARM 16.14.505, 520, 521	Applicable	
ARM 16.42.101, 102	Applicable	
ARM 16.44.106, 107 112, 113, 124	Applicable	Only Substantive Requirements
ARM 16.44.303, 310, 311, 321, 322, 323, 324, 330, 333, 416, 511, 512, 702	Applicable	
Hazardous Waste Act		
MCA 75-10-101, 102 and 202	Relevant and Appropriate	Policy statement
MCA 75-10-212, 214	Applicable	
MCA 75-10-402, 414, 416, 601, 711	Relevant and Appropriate	Policy statement

Table 19

Applicable or Relevant and Appropriate Requirements for Upper and Lower Aquifers

The following requirements have been identified as applicable or relevant and appropriate to the response action selected for clean up of contaminated ground water in the upper and lower aquifers. Specific citations for United States and State of Montana statutes and regulations are provided along with a distinction between "applicable" or "relevant and appropriate." In some instances, comments are provided for further information. These ARARs have been identified on the basis of preliminary design criteria for the selected alternative for the upper aquifer, in-situ bioremediation. Final remedial design may reveal other response action ARARs which should be taken into consideration for remedial action. ARARs for lower aquifer clean up should be the same as for the upper aquifer, and they are included here in order to establish the ARAR waiver documentation. The site administrative record contains extensive documentation on ARARs, and it should be reviewed for more insight into the identification and selection process.

Statute or Regulation/Citation	Applicable or Relevant and Appropriate	Comment
Executive Order 11990 40 CFR Part 6	Applicable	
Clean Water Act, Section 404, 40 CFR Parts 230 & 231	Applicable	
Endangered Species Act 50 CFR Parts 200 and 402	Applicable	
Safe Drinking Water Act 40 CFR Part 141	Relevant and Appropriate	
Underground Injection Control Act 40 CFR Part 144	Relevant and Appropriate	

Table 19 Continued

Statute or Regulation/Citation	Applicable or Relevant and Appropriate	Comment
Occupational Safety and Health Act 29 CFR 1926 Sub-Part P and 1910	Applicable	
Resource Conservation and Recovery Act 40 CFR 264, Sub-Part J	Applicable and Relevant and Appropriate	Old & New Tanks
Nondegradation of Water Quality ARM 16.20.702	Applicable	
ARM 16.20.703	Relevant and Appropriate	Only Substantive Requirements
Pollution Discharge Elimination System ARM 16.20.916	Applicable	
Ground Water Pollution Control System ARM 16.20.1002, 1003, 1010, 1011	Applicable	
ARM 16.20.1013, 1015, 1016	Applicable	Only Substantive Requirements
Public Water Supplies ARM 16.20.201	Relevant and Appropriate	Only Substantive Requirements
ARM 16.20.203, 204, 205 and 207	Relevant and Appropriate	
MCA 75-6-101	Relevant and Appropriate	Only Substantive Requirements
MCA 75-6-112	Relevant and Appropriate	
Water Well Standards ARM 36.21.635, 638, 640-662, 664-679	Applicable	

Table 19 Continued

Statute or Regulation/Citation	Applicable or Relevant and Appropriate	Comment
Water Use		
ARM 36.12.103	Applicable	
MCA 85-2-101	Applicable	Policy statement
MCA 85-2-301	Applicable	
MCA 85-2-306	Applicable	Only Substantive Requirements
MCA 85-2-317	Applicable	
MCA 85-2-401 thru 418	Applicable	Only Substantive Requirements
MCA 85-2-505, 506, and 507	Applicable	
Solid and Hazardous Waste Management		
ARM 16.44.335	Applicable	
Non-Game and Endangered Species		
ARM 12.5.201	Applicable	
MCA 87-5-501	Applicable	Policy Statement
Historical Preservation		
ARM 12.8.501	Relevant and Appropriate	Policy Statement
ARM 12.8.505, 506	Applicable	

ground water cleanup criterion will be the new MCL.

A change in the MCL for pentachlorophenol is anticipated to be proposed in late 1988. The new concentration could be as low as 0.2 mg/L. Should this MCL be promulgated in final form prior to finalization of the ROD it will be considered relevant and appropriate to the Libby site, and the penta ground water cleanup criterion will be the new MCL. Also, the recent reclassification of penta as a probable human carcinogen (see discussion below) could lower the new MCL to a much lower concentration.

It is anticipated that another change involving pentachlorophenol could have significant impact upon the site cleanup requirements. Penta has been considered by EPA as a Class D carcinogen, meaning that there are no carcinogenic effects associated with the compound. Recent studies have caused EPA to re-evaluate that stance, and penta has been reclassified as a B2, probable human carcinogen, based upon evidence of carcinogenicity in animals. This determination will require publication of carcinogenic potency factors for the compound which have previously not been used. Risks associated with penta for the Libby site has been based primarily on non-carcinogenic effects. The availability of carcinogenic potency factors for this compound may have significant impact upon cleanup criteria, which have been based to date on land disposal restrictions BDAT (soils) and a health advisory for ground water. Should potency factors be published prior to finalization of this remedy selection document, new risk calculations will be conducted and cleanup levels may be revised.

Potency factors under consideration by EPA have been reviewed by Libby project personnel. A range of potency factors has been prepared, the value of which is dependent upon the type of pentachlorophenol found on site. Comparison of these potency factors to the potency factors used in Libby risk assessment suggests that the 37.00 mg/kg BDAT treatment requirement will provide a protective cleanup level within the acceptable range of risk.

Cost Effectiveness

The selected remedial alternatives are cost effective options for Libby site cleanup. This determination is based on the cost and overall effectiveness of the selected remedies when viewed in light of the cost and overall effectiveness of other alternatives.

For soils and source areas cleanup, enhanced bioremediation and land treatment (alternative 5A(1)) is more costly than land treatment without a liner and capping, but less costly than other treatment alternatives. This alternative will degrade contaminant concentrations to acceptable levels which are protective of human health. Land treatment with a liner may provide a substantial amount of greater environmental protection than land treatment without a liner. The only alternative which will achieve greater treatment efficiencies is incineration. Incineration will reduce organic concentrations lower than land treatment, but there will still be potentially hazardous ash products to dispose and cap on site. Land treatment with a liner is considered to be the most cost effective remedy.

In-situ biodegradation of the upper aquifer is the least costly treatment alternative. In-situ biorestoration will effectively degrade contaminant concentrations to acceptable levels in a relatively short time frame. It is considered a more effective, more permanent remedy than either pump and treat alternative, because degradation of contaminants in the ground water and contaminants adsorbed onto aquifer matrices will occur simultaneously. In-situ biodegradation is considered to clearly be the most cost effective remedy.

A cost effectiveness evaluation of the final remedies evaluated for remediation of the lower aquifer cannot be completed. As stated, the preference to conduct a field test of in-situ biodegradation potential as an interim remedy will allow collection of needed data to make comparisons. Oil recovery alone, and treatment of oils and ground water in the lower aquifer, would clearly be a cost-intensive process with limited effectiveness. If in-situ biodegradation proves to be technically practicable in the lower aquifer it is believed by EPA that it will also be a much more cost effective alternative than any other proposed to date for this sub-action.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable, and the Preference for Treatment as a Principal Element of Selected Remedies

The selected remedies satisfy the statutory preference for utilization of permanent solutions and alternative treatment technologies. Treatment is a principal element of the alternatives selected for all sub-actions. The remedies selected for cleanup of soils/source areas and the upper aquifer will treat contaminant concentrations to acceptable health based levels. They are permanent solutions in that they will destroy contaminant concentrations, not merely transfer pollutants to another media for eventual disposal. Enhanced bioremediation of the soils area is considered an innovative technology when utilized in the approach discussed in this document. A combination of land treatment with in-situ, source area degradation in the saturated zone of the waste pit will effectively reduce all potential contaminant exposure routes permanently.

In-situ biorestoration of the upper aquifer is considered an innovative approach to ground water remediation which has obvious implications for sites across the country. The alternative presented in this remedy selection will permanently destroy contaminant concentrations in place, without having to perform intensive pump and treatment actions. Additionally, the in-situ program is expected to be much more effective, in a shorter timeframe, than traditional pump and treatment scenarios. Finally, whereas pump and treat ground water extraction systems have been hampered by an inability to extract contaminants adsorbed onto particle surfaces and in micropores, the in-situ biodegradation process will work concurrently on all areas of contamination within the aquifer.

It is hoped that an in-situ biorestoration program for the lower aquifer will prove to be effective as well. However, the types of contamination (product pools and aqueous phase) found in the lower aquifer suggest that active biodegradation will be much more difficult to initiate. It should be recognized that other treatment alternatives, such as the oil recovery systems based on oil reservoir technology, would have only limited effectiveness at the Libby site. The high cost of implementation, the low effectiveness and the extremely long time frame required to achieve desired cleanup levels make oil recovery an impracticable alternative. In-situ biorestoration, alone or in conjunction with other technologies considered, is the only potential cleanup alternative which EPA has been able to identify worth pursuing.

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Libby Ground Water Site
Responsiveness Summary

Attachment A

Responsiveness Summary

for the

Libby Ground Water Site

Libby, Montana

The U.S. Environmental Protection Agency (EPA) and Montana Department of Health and Environmental Sciences (MDHES) held a public comment period, on the Proposed Plan and Feasibility Study Report for the Libby site, from November 11 through December 12, 1988. Both the Proposed Plan and the FS report were made available to the public for the entirety of the public comment period. In addition, the administrative record for the site was available for review in the County Sanitarian's Office (the information repository) in Libby during the public comment period. A public meeting was held in Libby on November 29th to discuss the Proposed Plan and FS Report, and other site issues, with concerned citizens and public officials. This Responsiveness Summary has been prepared to document questions or concerns raised by persons at the public meeting and provide EPA's responses. Written comments received during the public comment period are also responded to in this document.

The public meeting was held at the Lincoln County Annex Building in Libby, Montana, on November 29, 1988 from 7:00 p.m. to approximately 9:30 p.m. Those attending the meeting included representatives from EPA, MDHES, Champion International Corporation and it's project consulting firm, Woodward-Clyde Associates, members of the Lincoln County Board of Health, other city, county and state public officials, news media representatives, and citizens of Libby and/or Lincoln County. Also, a Court Reporter and Notary Public of the State of Montana reported the proceedings of the meeting in a stenographic transcript, available for review in the site administrative record.

An agenda was prepared for the meeting and provided to attendees, along with a copy of the Proposed Plan and a meeting briefing package for later reference. EPA, MDHES and Champion presented a review of the Superfund regulatory authorities, a brief history of the site, an explanation of the results of the Feasibility Study, a review of the alternatives evaluation results, description of the detailed alternatives, and information on the remedy selection process. Questions were answered throughout the meeting. No specific comments were made during a separate public comment period at the end of the meeting.

History of Community Relations Activities

Contamination of ground water was first reported in Libby in 1979. At the time, many residents were apparently skeptical of the analytical results for ground water samples, but residents became more aware of the magnitude of the contamination problem after stories were written in the local newspapers and public meetings were held. During early testing of ground water wells, EPA and State representatives met and discussed their activities with the individual well owners. Many residents preferred to have Ron Anderson, the Lincoln County Sanitarian, as a focal point for these issues. EPA and the State have continued to rely on Mr. Anderson for contact with the community, as have corporate and regional representatives of St. Regis and Champion.

News releases and fact sheets have been issued in conjunction with significant site activities. Local newspaper coverage was more extensive during early site activities, prior to the first Record of Decision for an alternate water supply. The following community relations activities have been conducted:

- News releases and fact sheets issued in conjunction with site nomination to the NPL.
- Phase I investigations results were sent by St. Regis to each homeowner whose well was tested.
- Results of the Phase I investigations and the consent decree process were presented to the public for review and comment at the County Health Board's monthly meeting on October 18, 1983.
- In April 1984, a fact sheet recommending limited water use and well installation was included in the sewer bill mailing.
- In July 1986, a fact sheet was sent to area residents using the local newspaper as a distribution system.
- A public meeting was held on July 15, 1986 in the county annex, to discuss alternatives for providing clean water to local residents. This meeting initiated a 30-day public comment period.
- In January 1988, EPA and MDHES conducted community interviews with residents and public officials of Libby to gather information for revision of the Community Relations Plan.
- A progress report was distributed to persons on the EPA mailing list in June 1988, providing an update as to site activities.

- On November 11, a public comment period was initiated to address the draft Feasibility Study report and the Proposed Plan for site clean up. The comment period ended on December 12, 1988.

The remainder of the responsiveness summary will consist of Agency responses to questions and/or comments raised during the public comment period. The first portion will address questions and/or comments from the public meeting. Similar questions or comments from the meeting are combined into one for the responsiveness summary. Specific questions, comments and replies made during the public meeting may be reviewed in the meeting transcript. The second portion responds to a set of written comments from a Libby resident received at the end of the public comment period, and the last section consists of responses to written comments submitted by Champion International Corporation during the public comment period.

Public Meeting Questions and Comments

Question: Some persons questioned the locations of the contaminant sources. For instance, the butt dip tank area, tank farm area and waste pit area were identified by EPA and MDHES (the Agencies) as the prime contaminant source areas. However, some attendees suggested that there may have been at least one more dump area.

Response: Extensive site-wide sampling at Libby has not revealed other "source" locations. It is possible that the large source area, the waste pit, is actually a combination of two different dump sites, resulting in some confusion during the public meeting. However, because of the possibility that there may still be other waste locations on site not yet identified, EPA will conduct a review of records concerning waste dumping and burning locations to see if another source area has been inadvertently overlooked. The EPA project manager will also make a site visit with persons expressing this concern to try and pinpoint other potential dump locations. Finally, the Record of Decision has been written to allow for clean up of any as yet unidentified source areas during remedial action, but it is EPA's belief that all contaminant sources have been located.

Question: Many questions were raised about the depth of excavation to remove contaminated soils. Individuals expressed opinions that this would not be deep enough to take care of the contamination problem in the ground water. They recognized that oils and product have migrated down through time, and that there is probably a lot of source material at depths much deeper than the water table.

Response: EPA agrees that excavation of soils to the water table, and treatment of those soils, will not address a large portion of the site contamination. Excavation of soils below the water table would require a difficult set of engineering controls to depress the water table in the area to allow excavation. Because of the prolific ground water flow in the area further excavation would be very difficult and expensive. However, the selected remedies do provide for the clean up of source materials in the saturated zones below 15 feet or so. A rock percolation bed upgradient of the waste pit area will be used to filter treated water and oxygen and nutrients into the saturated zones to stimulate biodegradation of contaminants. Ground water and oil extraction wells will be placed just downgradient of the waste pit area to remove free product and highly contaminated ground water. Ground water will be treated on the surface and then reinjected through the rock percolation bed or injection wells. The purpose of this process is to isolate the high concentration source areas in the saturated zone from the rest of the ground water system. This will greatly reduce contaminant loading into the rest of the aquifer, and hopefully accelerate the natural contaminant biodegradation processes.

Question: A few individuals expressed concerns about institutional controls. Specifically, they suggested that controls such as the City prohibition on well drilling are a violation of individual property rights.

Response: The institutional controls considered for the site are designed to protect human health and the environment. For instance, the City prohibition on well drilling was passed because Libby did not want any other persons potentially exposed to ground water contamination. The other institutional controls under consideration are for use of property on the Champion site. As an example, one control might be used to prevent construction activities on contaminated areas. This will reduce the potential for human exposure to contamination. Finally, all institutional controls are prepared under appropriate legal advice so as not to violate individual rights.

Question: One person commented about the lack of response by EPA to questions he raised a couple of years ago concerning cancers in the Libby area which may be attributed to contaminated ground water and the site.

Response: EPA conducted some research into cancers in the Libby area. This information is contained in the administrative record. However, no conclusions were drawn from the research for a number of reasons. First, documentation of cancers into a database has only been conducted since the 1970s. Since wood treating operations were carried out at the Libby site from 1946 to 1969, no data is available to correlate cancers during contaminant use periods. Also, there is a relatively small population of persons which could be studied to determine cancers caused by ingestion of contaminated drinking water. Many of those persons probably worked at the Champion Plant, or other industrial locations, where exposure to various substances may have occurred. Therefore, the identification of causes of cancer may not be possible. In summary, even if a higher than normal cancer frequency could be determined for the near-site Libby population, it may be impossible to isolate the factors behind such a trend.

Question: Many questions were raised about the extent of ground water contamination. For instance, is there evidence of contamination south of the plant? Is there contamination in the ground water on the west side of Flower Creek? Some of these questions were related to concern about why some residents were not offered the buy-water plan for city water.

Response: These questions were answered explicitly during the public meeting using maps to reflect contamination extent. In summary, there is no evidence of ground water contamination south of the plant because of the very strong ground water flow to the north and northwest of the site. Contaminants have not been detected in ground water west of Flower Creek. Concentrations in wells near the Creek on the east side have always been extremely low, and often not detectable. If contaminant plumes were to migrate that far, EPA believes Flower Creek would act as a flow barrier, and contaminated ground water would either be discharged into the Creek or redirected along the flow of the Creek toward the Kootenai River. However, contaminant plumes do not appear to be migrating, based on extensive samplings conducted over the past few years. Natural organic degradation and contaminant adsorption onto matrix surfaces may have effectively halted any further migration. Finally, residents with private wells outside the area of ground water contamination were not offered "free" city water because they had no known exposure to the contamination. If plumes migrate in the future, and contaminate more wells, residents using those wells will be offered an alternate water supply under the buy-water plan under the provisions of the Record of Decision.

Question: Would pumping wells installed on site as part of the clean up program have any effect on private wells located near the plant?

Response: The large volumes of flow in the upper aquifer would preclude any impact on residential wells from the extraction wells considered in the FS report.

Question: What happens to the bacteria after it is done cleaning the contaminants from the ground water?

Response: The bacterial populations in question will be large as long as there are contaminants in the ground water. After contamination has been destroyed, the bacterial populations will rapidly decrease because of the lack of a food source.

Question: What will prevent contaminants from leaching into the water during treatment or in un-capped areas?

Response: Some leaching of contamination may occur in the waste pit area during treatment. However, the ground water extraction and injection system discussed in a previous response will prevent the leaching from being a problem. There should be no contaminant leaching in the land treatment cell because there will be a bottom liner providing a barrier to contaminant migration. There should be no areas with significant residual contamination that are not capped at the end of excavation and/or treatment.

Question: How long will it take to clean the aquifer?

Response: Preliminary modeling conducted for the FS report indicates the aquifer could be remediated in as little as five years. However, an estimate at this stage is relatively speculative.

Question: What effect would flooding, or high water recharge rates, have on land farming, and could it also alter the direction or speed of ground water flow?

Response: The land treatment unit will be placed in an area higher than the 100 year flood plain, making it unlikely that flooding or rain will impact the treatment area. Also, engineering controls will be used to keep the unit from being flooded. Large amounts of rain can raise the water table in the aquifer, but heavy recharge would probably have little impact on the direction and rate of ground water flow, other than short term effects. Variable ground water levels can have an effect on contaminant distribution within the system, but we have not been able to make such a correlation in Libby.

Question: Isn't there a contamination problem resulting from water washing over treated logs?

Response: It is probable that logs treated with chemicals lose some material onto the ground, through drippage and rain solubilization. This can cause contamination problems, and probably has in the past at Libby. However, there is no wood treating going on at Libby now so the logs stacked outside in the yard are not releasing wood treating contaminants.

Question: Will there be monitoring of ground water down gradient of the area where soils will be treated, to detect contaminant leaching?

Response: Yes. Monitoring of ground water using monitoring wells and soil-pore water using lysimeters will be conducted up gradient of, down gradient of, and within the waste treatment areas.

Question: What does the 36.75 rating in the historical sketch mean?

Response: That number, a product of the early site investigation, reflects a numerical score given the Libby site to assess how much of a threat to human health and the environment it was causing. Sites which received a score of 28.5 or over are eligible for placement on the National Priorities List of hazardous waste sites.

Written Comments - Libby Resident

What assurance is there that the buy-water plan will be continued?

The buy-water plan, as noted by the commenter, is funded by Champion International. However, implementation of the buy-water plan was authorized by EPA in the Record of Decision for the First Operable Unit, signed September, 1986. This decision and the current Record of Decision mean that EPA will assure that the buy-water plan will be continued as long as there is a threat to human health via ingestion of well water. This will be required of Champion in the consent decree which is expected to be entered concerning this ROD.

What are the plans to take care of other areas (re: buy-water plan) if contamination should spread?

The 1986 Record of Decision and this Record of Decision also addressed this concern. If contamination in the aquifer should spread outside of the areas currently identified, the buy-water plan will be extended to all newly impacted well owners and users. In fact, additional persons have been added to the buy-water plan since implementation. Alternative water supplies will be provided to anyone being impacted by the contaminant plumes, whether they reside within the city limits or not.

There are at least 3 springs west of Libby that have not been monitored in any way.

EPA has not sampled the springs west of town. However, private wells and monitoring wells between the springs and the known extent of ground water contamination have been checked on a periodic basis. As long as these wells are free of contamination the springs should also be free of contamination emanating from the Champion plant.

The wastes must go much deeper than 15 feet, the depth of excavation. The excavation should go much deeper to get a thorough idea of the amounts of contamination.

This comment was addressed in response to questions raised during the public meeting on previous pages. EPA believes that there is sufficient information to warrant making a clean up determination for the source areas. The problems with excavating deeper than the water table were previously addressed.

Re: City or County ordinance prohibiting well drilling - Is this not taking away part of your property value and rights?

The ordinance prohibiting well drilling in Libby is believed to be within the legal discretion of the City. It is worth remembering that the purpose of the ordinance is to prevent additional human exposure to potentially harmful chemicals in the ground water. A county ordinance would also be enacted, if required. With regard to property value, EPA is not aware of any impact this ordinance has had upon property values in Libby.

Placement of a cap over areas to reduce water infiltration is a waste of time, considering ground water will continue to spread contaminants.

EPA believes that the caps placed over excavation and treatment areas will accomplish two things. First, they will reduce the potential for further contaminant loading to the aquifers by reducing water infiltration and contaminant leaching. Second, and more importantly, the caps will provide an additional protective measure against direct human exposure to residual contamination.

At what point will EPA funds step in if Champion does not pay for the remedy or stops funding the remedy?

This Record of Decision authorizes EPA to carry out the preferred remedial alternatives selected, regardless of who pays for the clean ups. Champion International Corporation, as the responsible party for the Libby site, has expressed a strong desire to continue to pay for and conduct the response actions at the Libby site. EPA does not anticipate that Champion will change its decision, based on Champion's input to the administrative record for the site. However, if responsible party refuses to carry out the selected remedial action, one of EPA's options is to use money from the Superfund Trust Fund to pay for site clean up.

Written Comments - Champion International Corporation

Champion International Corporation provided written comments to the Proposed Plan. These comments were based on the information in the Proposed Plan and information given by EPA and MDHES at the public meeting. Champion's comments are directed at four main areas: Ground water clean up levels, Soil clean up levels, Compliance with applicable or relevant and appropriate requirements of the land disposal restrictions (Land Ban) and the Remedial action plan for the lower aquifer. Champion's comments are attached, followed by EPA responses to those comments.

F FILE NUMBER
14.3

ADMINISTRATIVE RECORD

ENVIRONMENTAL PROTECTION AGENCY
DEC 08 1988
MONTANA OFFICE

GROUND WATER CLEAN UP LEVELS

EPA's proposed ground water clean up level indicated at the public meeting on November 29, 1988 included:

- Pentachlorophenol - 0.2 mg/l
- Total PAH - 0.4 ug/l
- Total suspected carcinogenic PAH 0.04 ug/l

Currently there is no final MCL for pentachlorophenol and no ARAR requirement exists for this compound. Thus, the pentachlorophenol cleanup level must be risk-based. The pentachlorophenol cleanup level should be based on potential fetotoxic effects and established at the lifetime Health Advisory Level of 1.05 mg/l (Table 4-4 of Feasibility Study).

To date, appropriate scientific rationale has not been provided by the EPA for the total PAH compound cleanup level of 0.4 ug/l. Other than for the suspected carcinogenic PAH compounds, (addressed separately and discussed below) there is no evidence provided by the EPA for PAH compound risk to humans or the environment. Champion has not been provided with any risk evaluation supporting this cleanup level. Therefore, Champion proposes that this cleanup level be dropped.

No MCL exists for PAH compounds and thus there is no ARAR for use in establishing cleanup levels. Based on a literature study, a list of suspected carcinogenic PAH compounds (fluoranthene through indeno(123, cd)pyrene) were identified for this site. However, there are no individual carcinogenic potency factors for this list of PAH compounds. The benzo(a)pyrene potency factor is assumed for all compounds. Benzo(a)pyrene (BaP) is believed to represent the most toxic compound in this group. However, due to the very low mobility of BaP in the ground water, BaP and other heavier PAH compounds are not found, or projected to be found in the off-site ground water at Libby. Thus, the estimated carcinogenic risk levels for PAH compounds presented in the FS are highly conservative (page 4-24 of FS).

The conservative estimation of PAH compound carcinogenic risk (based on BaP toxicity) results in a further problem: the reliable measurement of PAH compounds at sub-part-per-trillion (ng/l) levels. The practical analytical detection limit for most carcinogenic PAH compounds is around 0.1 μg/l for each compound. Pilot demonstrations of the proposed remedial technology, in-situ bioremediation, have indicated that cleanup to the practical analytical detection limit may be achieved at this site. However, cleanup to lower levels, such as EPA's proposed 0.04 μg/l, has not been demonstrated.

Since EPA's proposed 0.04 μg/l cleanup level is below the practical analytical detection limit and has not been demonstrated to be met by the proposed technology, Champion proposed an interim cleanup target of 0.1 μg/l for each suspected carcinogenic PAH compound (page 4-24 of FS). Champion further proposed that this interim level be reevaluated when it is shown that ground water remediation is approaching this target. A final cleanup level would then be set which is protective of human health and the environment, considering appropriate technological limitations (in accordance with CERCLA requirements) and updated toxicological data concerning the appropriate PAH compounds' carcinogenic potency. EPA is currently developing PAH compound potency factors for compounds other than BaP.

SOIL CLEANUP LEVELS

At the FS public meeting on November 29, 1988 the EPA proposed soil cleanup levels, including the following:

- Pentachlorophenol - 36.75 mg/kg
- Total Suspected Carcinogenic PAHs - 88 mg/kg

EPA's proposed pentachlorophenol cleanup level is apparently based on the August 17, 1988 Federal Register land disposal restriction regulations and K001 nonwastewater treatment standards. This is not a risk-based cleanup level, but it is an ARAR. Compliance with this ARAR is addressed in a separate attachment to this letter, "Compliance with the Land Ban ARAR." As indicated by the discussion in that attachment, the land ban ARAR schedule for meeting the K001 nonwastewater treatment standards is not in effect until August 8, 1990. Thus, establishment now of a pentachlorophenol cleanup level, which is not risk-based, is not justified.

In the Feasibility Study Champion proposed a cleanup level of 100 mg/kg instead of EPA's proposed cleanup level of 88 mg/kg. EPA's proposed soil cleanup level for suspected carcinogenic PAH compounds is based on the assumed exposure to a construction worker. A number of assumptions are needed to establish a scenario whereby a construction worker could be exposed to contaminated soil, especially soil that has been land treated, covered and fenced at closure. These assumptions produce considerable uncertainty in the risk estimates for this exposure scenario. For example, to arrive at the 88 mg/kg cleanup level, it was assumed that the construction worker ingests 480 mg (1/20 of a teaspoon) of contaminated soil per day. If the ingested amount were 413 mg/day (1/25 of a teaspoon) the estimated cleanup level would be 100 mg/kg for suspected carcinogenic PAH compounds. Similarly, a 4 month (17.3 week) exposure period was assumed for the construction worker scenario. However, if the exposure period assumption was set at a 3.4 month (14.9 week) period the estimated cleanup level would again be 100 mg/kg.

These examples indicate the uncertainty in the risk estimates, and the importance of considering the effect of assumptions in evaluating risk. This is especially true since there is no standard set of assumptions for the exposure scenarios developed for soil. Thus, we do not believe it is appropriate to select a number that results from a preselected exposure model without considering other relevant factors including the assumptions, their influence on the estimate, and thus, the degree of confidence in the estimate. As is illustrated above for the construction worker exposure scenario, we have no reason to believe that the exposure dosage and exposure duration are exact. Thus, the risk estimate should not be treated as exact.

As indicated in the FS (page 4-29) the preferred remedial alternative (land treatment) will provide additional exposure controls (i.e., clean cover, deed restrictions, access control and security) which are not explicitly treated in the risk assessment model. Given the added protection provided by an engineered land treatment facility, we believe a cleanup level which is rounded up from 88 mg/kg to 100 mg/kg is justified. We also believe that 100 mg/kg better reflects the uncertainty in the estimate, by setting an order of magnitude value.

COMPLIANCE WITH THE LAND BAN ARAR

Section 4.5 of the Feasibility Study (page 4-15) addresses the requirements for compliance with land disposal ban at the Libby site. However, based on recent conversations with the EPA and the EPA's proposed pentachlorophenol cleanup level for soil (discussed earlier), it is unclear to Champion how EPA presently views compliance with the land ban. Below we present our interpretation of the August 17, 1988 Federal Register land disposal restrictions.

The land disposal restrictions for K001 wastes is an ARAR for the Libby site. The effective land ban date for K001 soil and debris is August 8, 1990. As EPA discusses in the Rule publication, a policy decision was made to extend the effective dates of this Rule for contaminated soil and debris. Thus, the land ban ARAR has been established for the Libby site, but treatment standards for K001 nonwastewater (page 4-18 of FS) are not required to be met during land treatment until after August 7, 1990. Starting on August 8, 1990, and unless the land ban requirements are waived by the EPA, operation of the land treatment unit must demonstrate treatment of the listed compounds for K001 nonwastewaters to the treatment standards established by the rule.

If land treatment is the approved remedial action for soils at this site, Champion plans to start full-scale operation of the land treatment unit during the summer of 1989. Land treatment of contaminated soils may not be completed by August 8, 1990. Thus, continued operation of the land treatment unit past this effective date will require; 1) a demonstration that the unit can achieve the K001 land ban treatment standards or 2) a demonstration of no migration of contaminants from the unit. It is Champion's plan to collect appropriate data for these demonstrations during operation of the land treatment unit in the 1989 and/or 1990 treatment seasons. However, data collected in 1988 from a pilot demonstration unit indicated that achieving the K001 treatment standard may not be feasible.

If this is found to be the case, the demonstration of no-migration would be relied upon by Champion for continued operation of the land treatment unit.

A successful demonstration of no migration of contaminants for a K001 waste would exempt the waste from restrictions imposed by 40 CFR Subpart 268 (land ban). The no migration demonstration criteria address the specific waste and operations of concern, and is not a waiver for selected contaminants nor can it be applied to a different operation or site. Thus, if a waiver is granted for the Libby site, it would apply to the waste material addressed in the Libby demonstration, and exempt land treatment of this waste from the land disposal ban requirements.

LOWER AQUIFER REMEDIAL ACTION PLAN

In the EPA's Proposed Plan for the Libby Ground Water Site, a two-year test of in-situ bioremediation was proposed for the lower aquifer to determine if such a technology is effective, and implement it, if found to be effective. The potential effectiveness of the in-situ bioremediation technology was addressed extensively in Appendix F of the Feasibility Study (FS) and summarized in Section 5.0. Based on this evaluation, we do not believe that there is any technical basis for preselection of this technology as the remedial action for the lower aquifer. To date, no technical or cost information supporting EPA's proposal for selection of this technology for the lower aquifer has been provided to Champion or reviewed by Champion in the Administrative Record. This technology has not been selected in any other ROD nor employed at another site and thus is not technically supported. Below we summarize our findings regarding the application of in-situ bioremediation to the Lower Aquifer (Operable Unit C) at the Libby site.

Use of the in-situ biodegradation technology for dissolved phase contaminant remediation has potential for success, as demonstrated for the upper aquifer. However, the application and potential for success of in-situ biodegradation is significantly different for the degradation of the free phase oil within the lower aquifer. The reasons that the remediation potential is low for the lower aquifer are: 1) the high PCP concentrations in the oil severely retard the oil degradation, 2) degradation of the oil only occurs at the oil-water interface, thus significantly slowing the degradation rate, 3) the injected water, oxygen and nutrients would tend to flow over the oil phase where the permeability is higher, thus the injected solution will not efficiently disperse or enhance biodegradation in the oil phase, and 4) the complicated stratigraphy and the occurrence of the oil in many separate reservoirs would make it difficult to direct the oxygen and nutrients efficiently to degrade an oil pool.

Because of the above listed problems, the use of in-situ biodegradation in the lower aquifer to degrade the dissolved phase could be successful only in the near term. Unless continued for an extended period of time, it would not remediate the lower aquifer contamination, because as soon as water, oxygen and nutrient injection were discontinued, the contamination levels in the lower aquifer would rise due to the dissolution of the free oil phase which constitutes the majority of the contaminant problem. It is estimated that under the best conditions it would take at least 200 years for the aquifer to dissolve the oil. Thus, the use of in-situ biodegradation for long-term, permanent remediation of either the free oil phase or the dissolved contamination in the lower aquifer is not considered to be a feasible clean-up technique.

Because of the inability of the in-situ bioremediation technology to effectively remediate the lower aquifer in the near-term, it is not reasonable to expect that a two year test will provide useful data regarding its effectiveness. During such a short period, dissolved contamination may be reduced without any substantial degradation of pooled oil (the major contaminant source). Thus, results could erroneously demonstrate some effectiveness while not addressing the majority of the contamination. Overall, the potential for failure of the proposed test is high and a time frame of 2 years makes failure that much more likely.

The Monitoring Alternative (Alternative 2c) should be selected to evaluate, over the next 5 years, the potential for oil migration and contaminant recharge to the Kootenai River. This monitoring program will establish a better understanding of potential risks, if any, posed by leaving the contaminants in place. Currently, there is no evidence that the oil is migrating in the lower aquifer and there is no present use of the ground water from this zone.

Response to Champion Comments

on the Proposed Plan

The following responses have been prepared to address concerns raised by Champion International Corporation over various issues contained in the Proposed Plan and discussed at the public meeting on November 29, 1988. The responses are keyed by page and paragraph to the comments indicated on the previous pages.

Ground Water Clean Up Levels (pgs 1 & 2)

Para 1: EPA agrees with the first comment. The pentachlorophenol clean up level is 1.05 mg/L because the MCL referred to (0.2 mg/L) is not yet proposed or final. EPA would also point out that this determination was reflected during the presentation for the proposed plan. A clean up of 0.2 mg/L would be selected only if the MCL were proposed or finalized prior to ROD.

Para 2: EPA disagrees with Champion's contention that the clean up level for non-carcinogenic PAH compounds, or total PAH, of 400 ng/L (nano-gram per liter) should be dropped. The concentration selection is based on two primary factors. First, many compounds contained in creosote, which have not been commonly analyzed for at Libby, are suspected or known to be cancer-causing. These include some of the heterocyclic nitrogen base compounds like quinoline or benzocarbazoles, and the aromatic amines such as p- and o-toluidine.[11] A maximum level of total PAHs will provide additional assurance that all creosote compounds are being reduced to acceptable levels.

Another reason for setting a total PAH concentration limit is based on evidence that many PAH compounds are capable of promoting the carcinogenic activity of another cancer-causing compound. As an example, the non-carcinogens fluoroanthene, pyrene, benzo(e)pyrene and benzo(g,h,i) perylene, when applied simultaneously with the carcinogen benzo(a)pyrene, resulted in an increase in the total number of tumors when compared to only benzo(a)pyrene application.

There are a number of known or suspected cancer-causing chemicals found in ground water at the Libby site, including arsenic species, benzene, tetrachloroethylene and various PAH compounds. Pentachlorophenol has also recently been recognized as a probable human carcinogen. Known or suspected carcinogenic substances have been detected in most areas that non-carcinogenic compounds have been detected (Figures 7.23, 7.24, and 7.25 of the RI Report, April 1988). EPA bases its determination on this issue on the fact that a conservative clean up level for non-carcinogenic PAH compounds will reduce the potential of promotion of cancers at the Libby site. This justification has also been used in RODs for other Superfund sites, most notably the BN Brainerd site and the Reilly Tar and Chemical Company site. It is especially appropriate to have a conservative approach to clean up of non-carcinogens at Libby since the clean up level for carcinogenic compounds results in a 10^{-5} health risk.

From a technological perspective, the selected remedy for clean up of the Libby ground water system should easily achieve the clean up criteria set for non-carcinogenic PAHs because the compounds most difficult to degrade, the higher molecular weight PAHs, also have lower clean up levels in most instances. Therefore, if the clean up levels for carcinogenic PAHs are met, the non-carcinogenic clean up levels will most likely be achieved.

Para 3, 4, & 5: Para 3 is a description of the risk assessment process used. Champion's opinion that the estimated carcinogenic risk levels for PAH compounds in the FS are "highly conservative" is not shared by EPA. The rationale for development of the risk assessment in this fashion is well documented in the administrative record.

Para 4 discusses measurement of PAH compounds at low (ng/L) concentrations. Champion states that the practical analytical detection limit for most carcinogenic compounds is around 100 ng/L for each compound. EPA does not argue that detection of PAH compounds at the proposed clean up level, 40 ng/L, is not achievable using standard analytical techniques. However, based on a review of different laboratories, EPA has found that the 40 ng/L detection limit can be achieved currently using special analytical and sampling techniques, and method modifications.

Also, the need for low detection limits and special analytical techniques will not be required for some time at the Libby site. Low detection limits will be required when clean up proceeds to the stage that targeted compounds are not present in concentrations greater than 1 part per billion. This stage will probably not be reached for some years.

Finally, the selection of clean up level is based on protection of human health and the environment. The clean up level is not, as proposed in para 5, a floating target which will be finalized only when technological limits are determined.

Soil Clean Up Levels (pgs 3 & 4)

Para 1: Pentachlorophenol clean up and treatment levels are based on the BDAT treatment concentration for the compound as a K001 waste. The clean up level is considered an ARAR determined concentration. In order for soils and source area materials to be placed in the land treatment unit, after August 8, 1990, the ARAR concentration of 37.00 mg/kg must be achieved. If this concentration is not met then a demonstration of no migration will be used to allow placement and further treatment of wastes after the statutory deadline.

Para 2: EPA disagrees with Champion's rationale for selecting a clean up level of 100 mg/kg rather than the risk determined concentration for carcinogenic PAH compounds of 88 mg/kg.

Champion first addresses the uncertainties inherent in risk assessment. Examples are provided which show that with modification of certain factors, such as soil ingestion rate, the clean up level for a particular risk would change. EPA does not disagree with this conclusion, but merely points out, consistent with the Champion examples, that had higher ingestion rates or longer exposure periods been used in the risk calculations, the clean up level would have been reduced to below 88 mg/kg. This extreme sensitivity to analytical assumptions only emphasizes the need for conservative clean up levels.

Para 3: Champion again addresses the uncertainties in risk analysis and uses this as a basis for arguing that risk estimates should not be considered exact. EPA does not argue that risk analysis is an exact science. However, the assumptions used to develop the risk analysis were selected to a large extent by Champion, for reasons based on scientific merit. EPA had only minor modifications to these assumptions. This communication is contained in the administrative record. It has also been clear throughout the development of the feasibility study report, and the risk assessment, that EPA would select clean up levels based on protectiveness evaluations and ARARs.

Para 4: Champion argues that the additional exposure controls provided by the selected remedy help to justify a higher clean up level for soils. EPA has taken the additional exposure controls into consideration when selecting a clean up concentration which represented a risk value of 10^{-5}, rather than 10^{-6}. Were the additional exposure controls not available for the remedy a lower clean up concentration would have been required.

Compliance with the Land Ban ARAR (pgs 5 & 6)

Champion is correct in stating that the requirements of the land disposal ban regulations are applicable for certain activities to be done at the Libby site, if the Record of Decision (ROD) is implemented. The land ban regulations and the application of those regulations to the site are explained below.

Section 3004 of the Resource Conservation and Recovery Act, as amended, 42 U.S.C. Section 6904, establishes requirements for the land disposal of hazardous wastes, known as the land ban or land disposal regulations (LDR). Regulations implementing this statute are found at 40 CFR Part 268. These restrictions prohibit the land disposal of specified RCRA hazardous wastes beyond statutory dates established by Congress unless (1) the wastes are treated to a level or method specified by EPA, or (2) it can be demonstrated there will be no migration of hazardous constituents from the land disposal unit for as long as the waste remains hazardous, or (3) the waste is subject to an LDR exemption or a variance.

For purposes of LDRs, land disposal is defined as any placement of RCRA hazardous waste in or on the land, including placement of wastes into a land treatment unit, such as is proposed for the Libby site. Thus, the standards for K001 listed waste are applicable to waste which will be placed into the land treatment unit at the Libby site. Compliance with these requirements is measured at the point of waste entry, or placement, into the land disposal unit.

RCRA hazardous waste K001 is found at the site. Standards for K001 waste were promulgated in 53 Fed.Reg. 31138, August 17, 1988, and are promulgated at 40 CFR Part 268. The rulemaking establishes BDAT numbers for several PAH constituents and for pentachloraphenol, found in K001 waste. The rulemaking also grants a two year capacity extension for soil contaminated with K001 waste, such that land disposal of that waste does not have to meet the BDAT standards until August 8, 1990.

Placement of waste into the final land treatment unit at the Libby site will begin in 1989 and continue past August 8, 1990, probably into the 1991 field season. This placement will not violate the land ban prior to August 8, 1990, but, because waste contaminant levels are expected to be above BDAT numbers when waste is transferred from the waste pit into the final treatment unit, placement will violate the land band requirements after that date.

Accordingly, the ROD calls for Champion to submit a no migration petition and EPA to approve such petition prior to August 8, 1990. The petition must meet the requirements set forth in 40 CFR Part 268.6, and follow appropriate guidance. Initial review by EPA personnel, and a review of draft guidance, indicate that the site is a likely candidate for a no migration petition, because it provides for the destruction of the waste to levels near the BDAT levels after treatment, and because post treatment levels will provide for adequate protection of risk.

Despite the expected no migration variance from the land ban BDAT requirements, the BDAT number for pentachlorophenol was selected as a relevant and appropriate requirement for end of treatment levels. The BDAT number for pentachloraphenol represents a judgment by EPA of acceptable levels of contamination to be left in land disposal units. Pilot study data indicates that the BDAT number for pentachloaphenol can be met at the final treatment unit prior to closure of the unit. The number is also expected to provide adequate protection of human health, a concern since pentachlorophenol is now formally recognized as a probable carcinogen. Therefore, in keeping with the intent of the land ban requirements, the BDAT number for pentachloraphenol was selected as an enforceable requirement under section 121(d) of CERCLA for the cleanup of Libby site soils.

Champion is incorrect in statements which reflect its belief that the land ban requirements apply only to end of treatment requirements for land treatment units. As stated, the land ban requirements apply to waste at the point of entry into any land disposal unit, which includes land treatment units.

Lower Aquifer Remedial Action Plan (pgs 7 & 8)

Para 1: The evaluation of in-situ bioremediation presented by Champion in Appendix F of the Feasibility Study Report is not detailed or extensive enough to preclude further attempts to determine aquifer remediation potential. There is simply not enough information available to make such a recommendation. More information is required concerning hydrostratigraphic controls, product locations, and extent of contamination vertically and horizontally. The following replies to specific comments are provided.

Para 2: All of the discussion in this paragraph centers on the difficulties presented by attempting biodegradation of contaminants in a non-aqueous phase. EPA agrees that the degradation rates for product would be much slower, and thus more cost- and time-intensive, than degradation of dissolved contamination. However, this process is not envisioned for lab and pilot testing, nor for aquifer remediation. Rather, a combination of various technologies should be considered to remediate the system. The first step would be to remove as much product as necessary from the system using primary oil recovery techniques. A potential second step is to disperse the remaining oil throughout the aquifer as much as possible. Steam injection at depth could possibly be effective for this. Dispersal of oil would distribute contaminants throughout the aquifer matrix, thereby creating much more surface area on which microbial processes can occur. Also, an increase in temperature may increase product solubility, and enhance degradation rates. EPA recognizes that oil dispersion can potentially increase the vertical and lateral extent of contamination, as pointed out in Appendix F of the Feasibility Study report. This possibility will have to be carefully analyzed during the remediation evaluation stage.

Para 3: EPA agrees that aquifer remediation would have to continue until clean up levels are achieved and there is no more

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source (product) releasing contamination into the dissolved phase. However, estimates for the time required to clean up the aquifer using an approach similar to that described above have not been conducted.

Para 4: EPA agrees that a time requirement should not be established to carry out the studies necessary to make a final analysis of aquifer remediation potential. The two year test referenced in Champion comments and during the public meeting was merely an estimate of the time which may be needed. No time limitation is included in the ROD, although the time estimate is still discussed for planning purposes.

Para 5: Monitoring of contaminant concentrations and movement in the lower aquifer will be required during and after the study, regardless of the results of the study.

As Champion notes, there is no present use of the ground water from the lower aquifer. However, the lower aquifer is designated a potential use system. This is the over-riding reason why EPA will require that all possible avenues of aquifer clean up be thoroughly evaluated before selecting an alternative which prohibits use of the aquifer until it is clean by natural processes.

FCD:December 21, 1988:wallace:kw:comment